

## **Appendix A: Core Sample Data**

Operator: US Energy Research and Development Administration (ERDA)  
 Well Name: 1 Blacks Fork  
 State: Wyoming  
 County: Sweetwater  
 Township: 16N  
 Range: 108W  
 Latitude: 41.356508  
 Longitude -109.524952

Table 1. Attributes of core samples selected from the ERDA 1 Blacks Fork Core at the USGS Core Research Center in Denver, CO.

Sample #	Depth (ft)	Depth (m)	USGS Core Research Center Box #	Stratigraphic Unit
JTM-BF-2	397.46	121.15	17	Laney Member
JTM-BF-3	398.42	121.44	17	Laney Member
JTM-BF-4	400.5	122.07	17	Laney Member
JTM-BF-5	404.54	123.30	17	Laney Member
JTM-BF-8	412.83	125.83	18	Laney Member
JTM-BF-9	413.46	126.02	18	Laney Member
JTM-BF-10	414.92	126.47	18	Laney Member
JTM-BF-13	435.5	132.74	20	Laney Member
JTM-BF-14	437.67	133.40	20	Laney Member
JTM-BF-16	443.92	135.31	20	Laney Member
JTM-BF-17	446.13	135.98	21	Laney Member
JTM-BF-18	449.67	137.06	21	Wilkins Peak Member
JTM-BF-19	453.50	138.23	21	Wilkins Peak Member
JTM-BF-20	458.92	139.88	22	Wilkins Peak Member
JTM-BF-21	463.46	141.26	22	Wilkins Peak Member
JTM-BF-22	465.79	141.97	22	Wilkins Peak Member
JTM-BF-23	472.79	144.11	23	Wilkins Peak Member
JTM-BF-24	480.75	146.53	23	Wilkins Peak Member
JTM-BF-25	504.25	153.70	25	Wilkins Peak Member
JTM-BF-26	505.25	154.00	25	Wilkins Peak Member
JTM-BF-33	551.08	167.97	29	Wilkins Peak Member
JTM-BF-34	551.83	168.20	29	Wilkins Peak Member
JTM-BF-35	552.83	168.50	29	Wilkins Peak Member
JTM-BF-39	969.75	295.58	61	Wilkins Peak Member
JTM-BF-44	1006.67	306.83	64	Wilkins Peak Member
JTM-BF-50	1080.88	329.45	70	Wilkins Peak Member
JTM-BF-55	1141.38	347.89	74	Wilkins Peak Member

JTM-BF-57	1153.67	351.64	75	Wilkins Peak Member
JTM-BF-64	1203.92	366.95	79	Wilkins Peak Member

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Operator: Shell Oil Company  
 Well Name: 23X-2  
 State: Colorado  
 County: Rio Blanco  
 Township: 2S  
 Range: 98W  
 Latitude: 39.905464  
 Longitude -108.36224

Table 2. Attributes of core samples selected from the Blacks Fork Core at the USGS Core Research Center in Denver, CO.

Sample ID	Depth (ft)	Depth (m)	USGS Core Research Center Box #	Stratigraphic Unit
JTM-23X2-1	142.50	43.43	61	Parachute Creek Member
JTM-23X2-2	1659.96	505.96	62	Parachute Creek Member
JTM-23X2-4	1707.00	520.29	66	Parachute Creek Member
JTM-23X2-6	1735.21	528.89	68	Parachute Creek Member
JTM-23X2-8	1743.50	531.42	69	Parachute Creek Member
JTM-23X2-10	1866.46	568.90	78	Parachute Creek Member
JTM-23X2-12	1902.50	579.88	81	Parachute Creek Member
JTM-23X2-16	2009.75	612.57	90	Parachute Creek Member
JTM-23X2-23	2070.75	631.16	95	Parachute Creek Member
JTM-23X2-25	2074.17	632.21	96	Parachute Creek Member
JTM-23X2-32	2181.83	665.02	104	Parachute Creek Member
JTM-23X2-36	2196.33	669.44	105	Parachute Creek Member
JTM-23X2-37	2204.92	672.06	106	Parachute Creek Member
JTM-23X2-41	2220.67	676.86	107	Parachute Creek Member

## **Appendix B: Laminae Sample Locations**

Part 1: ERDA 1 Blacks Fork Core

Sample Depth: 121.2m

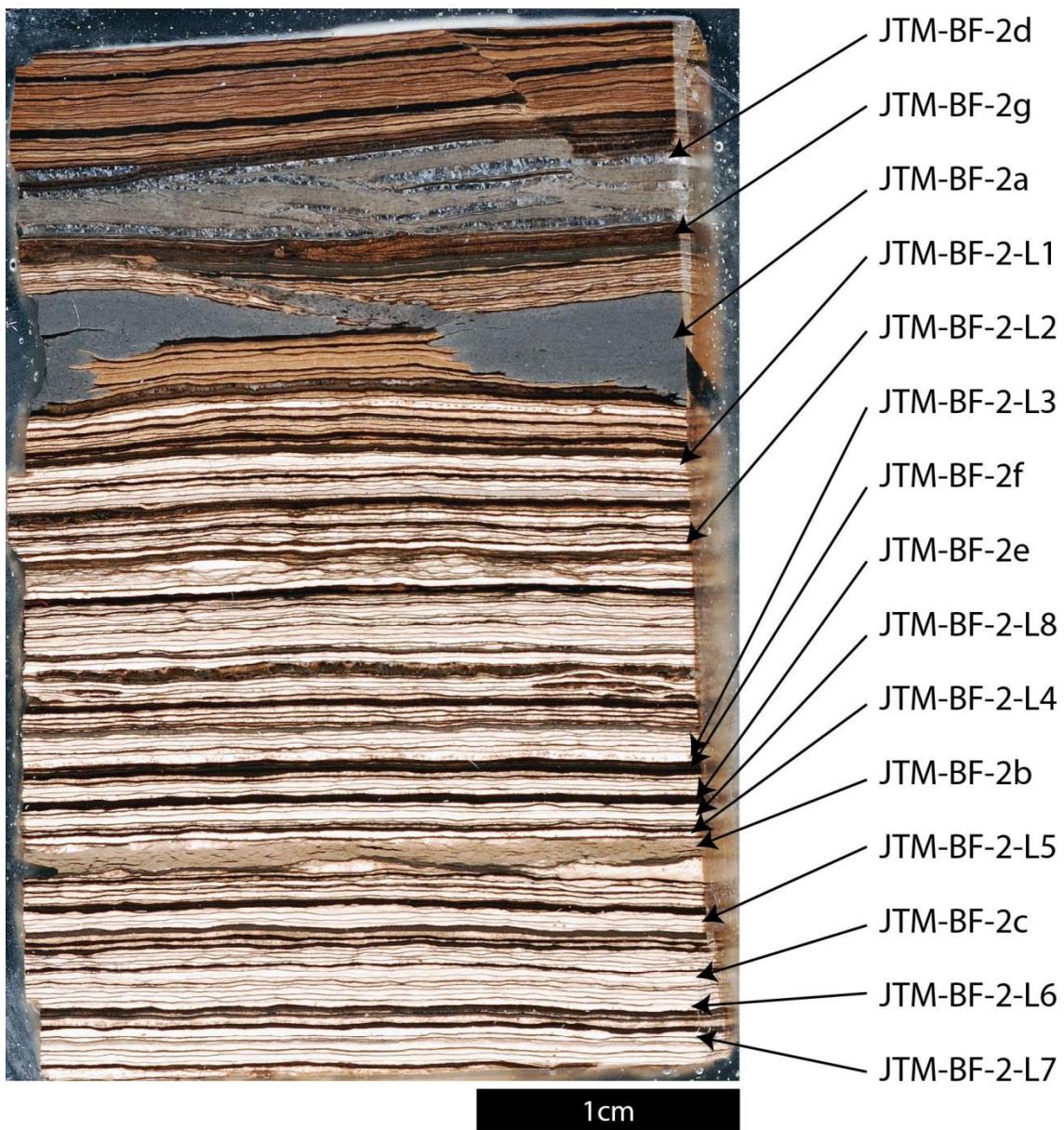


Figure 1. Laminae sample locations and hand sample image of JTM-BF-2, 121.2m.

Sample Depth: 121.5m

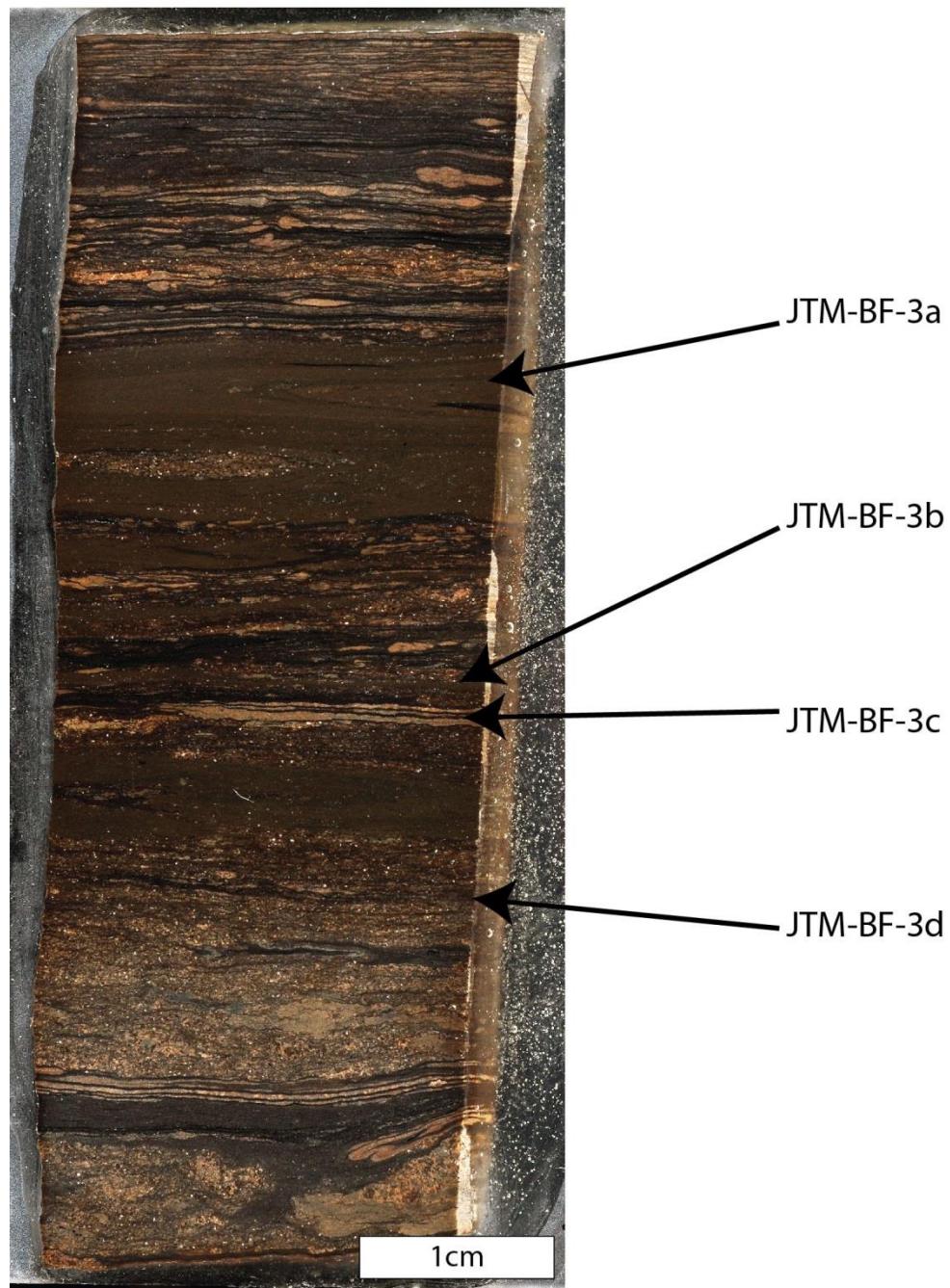


Figure 2. Laminae sample locations and hand sample image of JTM-BF-3, 121.5m.

Sample Depth: 122.1m

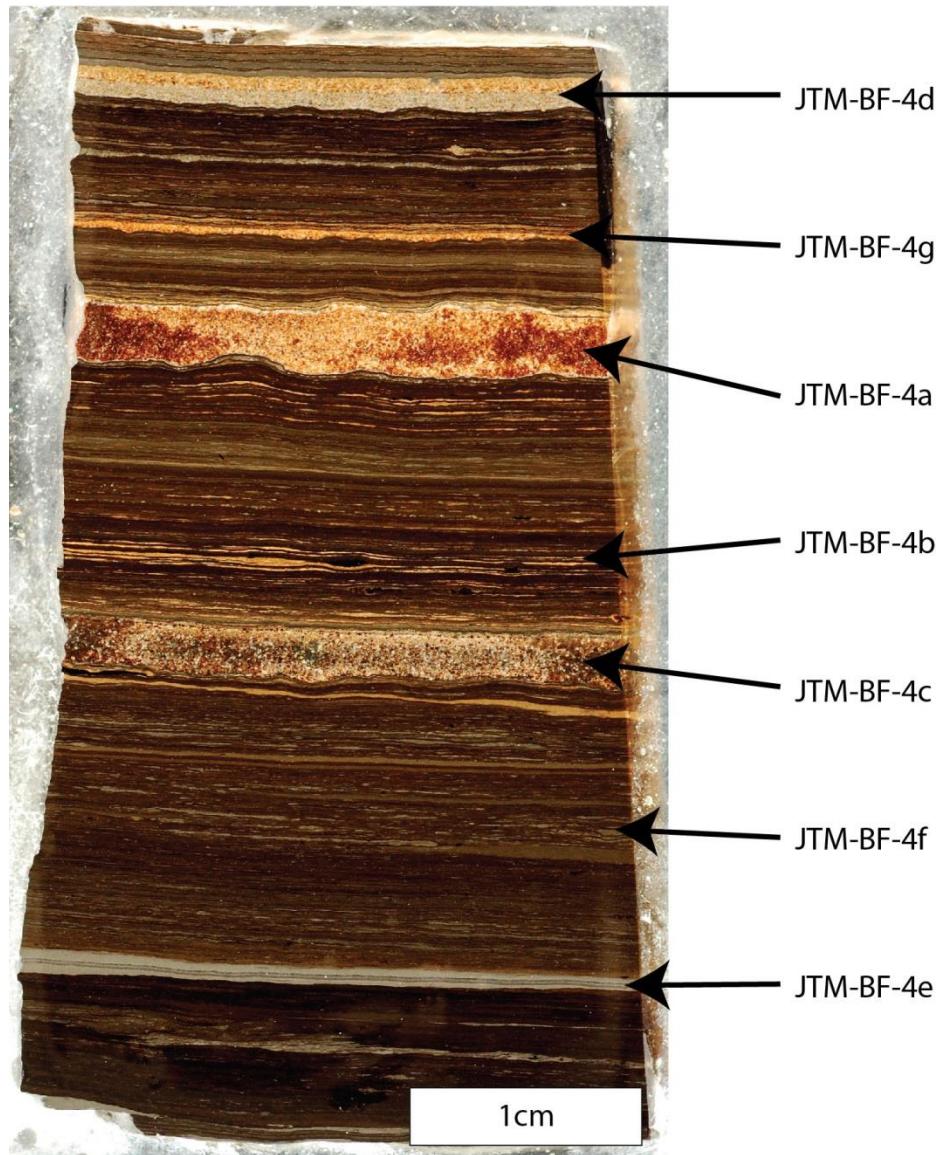


Figure 3. Laminae sample locations and hand sample image of JTM-BF-4, 122.1m.

Sample Depth: 123.3m

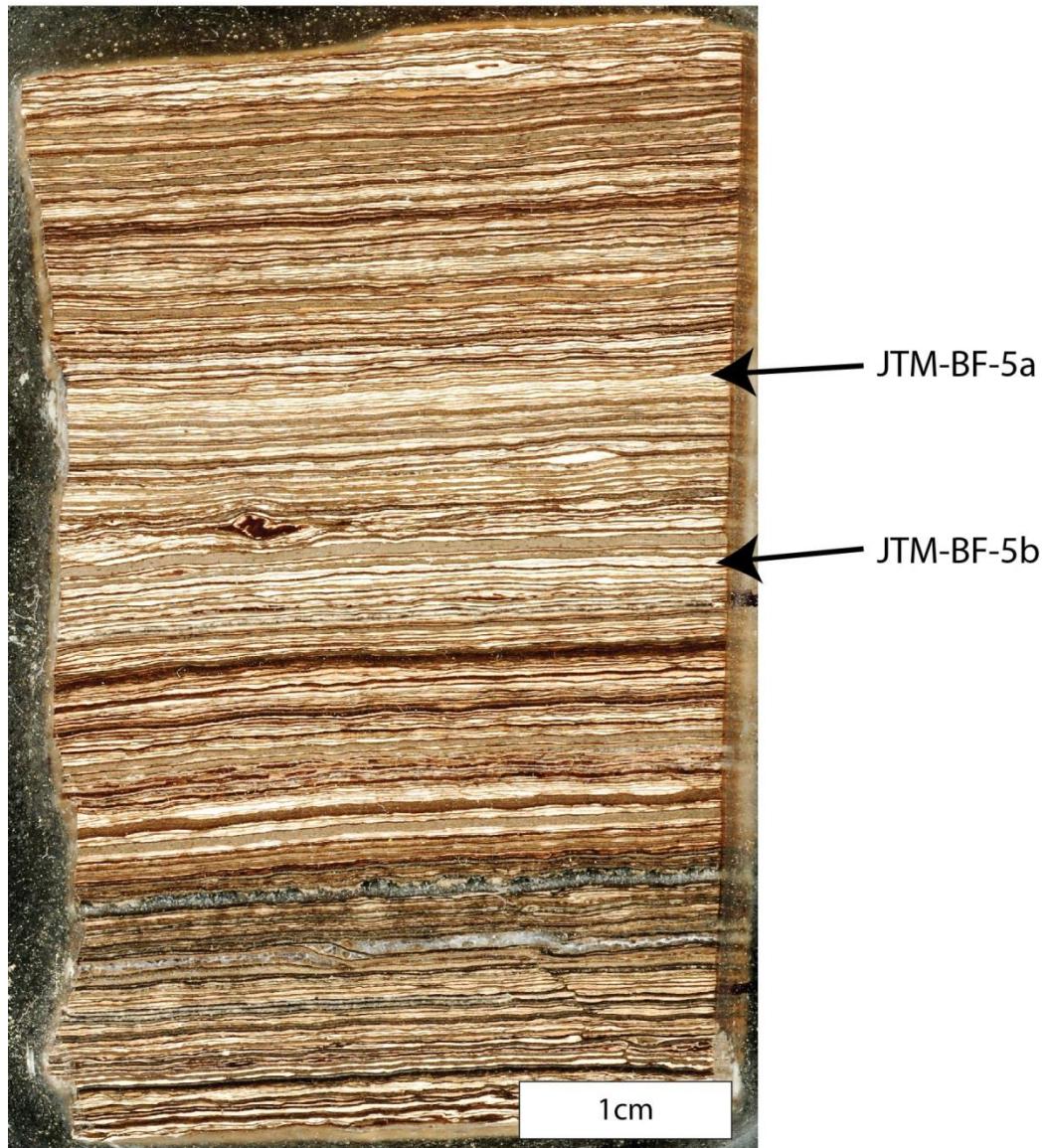


Figure 4. Laminae sample locations and hand sample image of JTM-BF-5, 123.3m.

Sample Depth: 125.8m



Figure 5. Laminae sample locations and hand sample image of JTM-BF-8, 125.8m.

Sample Depth: 126.0m

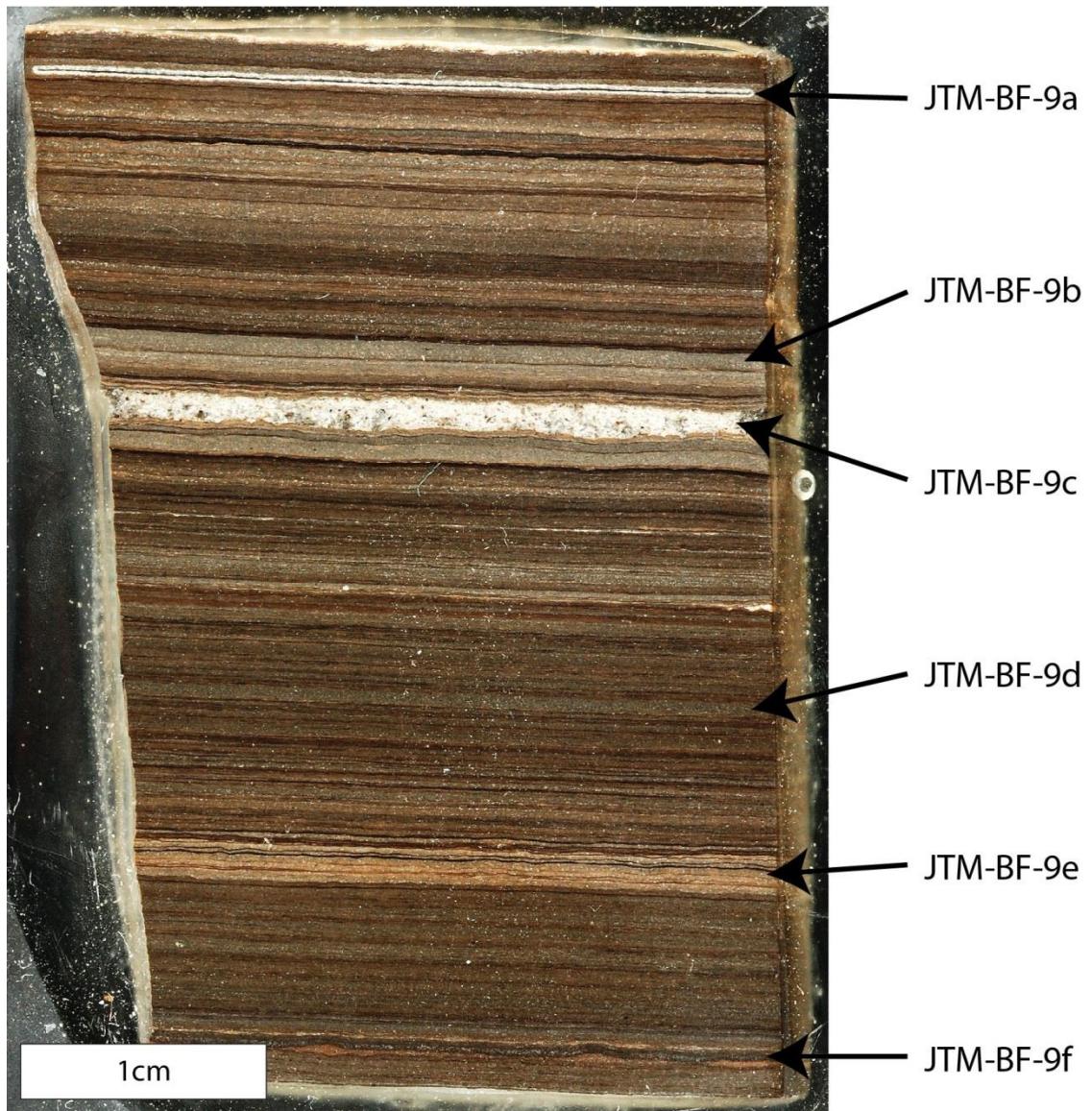


Figure 6. Laminae sample locations and hand sample image of JTM-BF-9, 126.0m.

Sample Depth: 126.8m

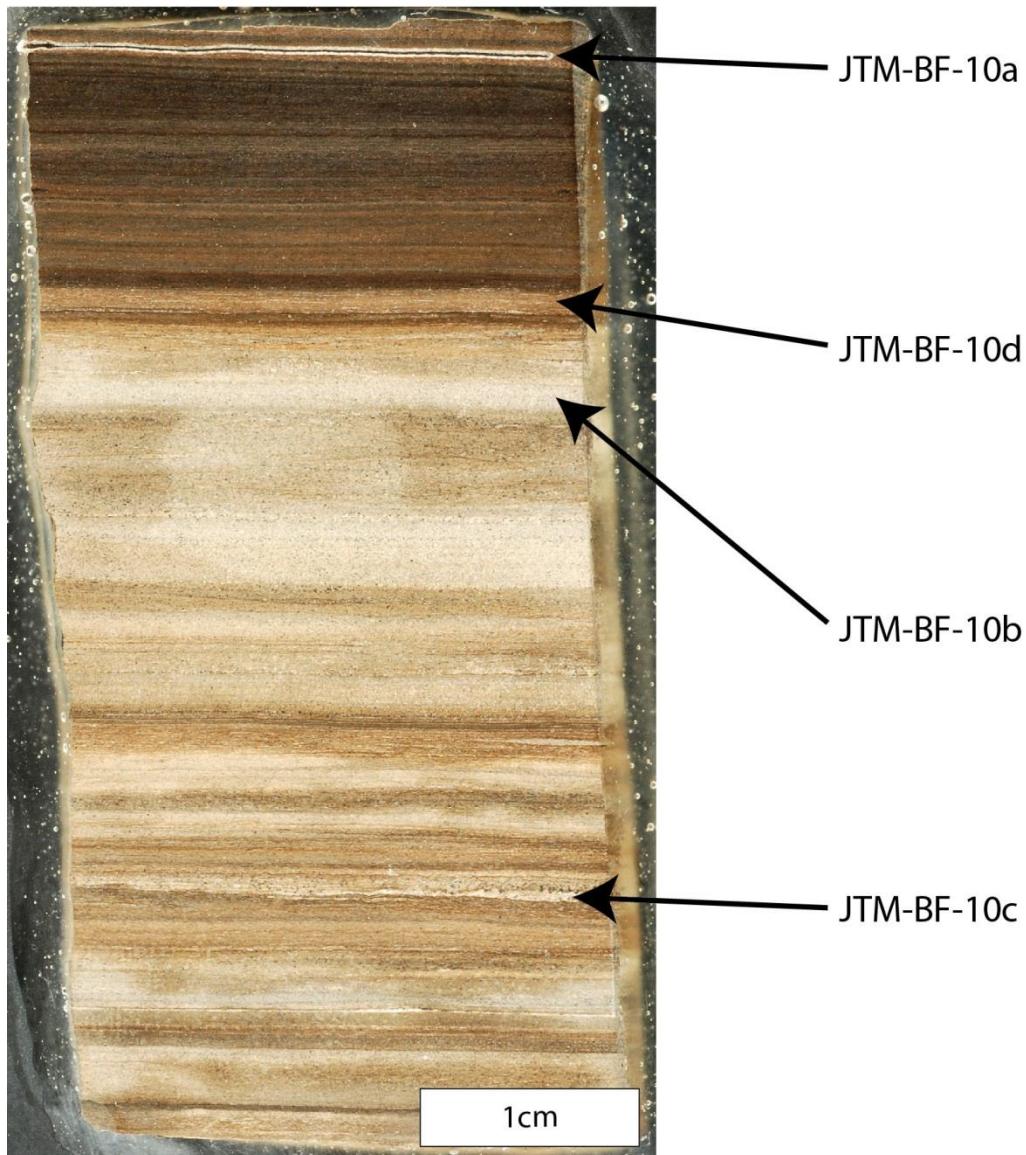


Figure 7. Laminae sample locations and hand sample image of JTM-BF-10, 126.8m.

Sample Depth: 132.8m

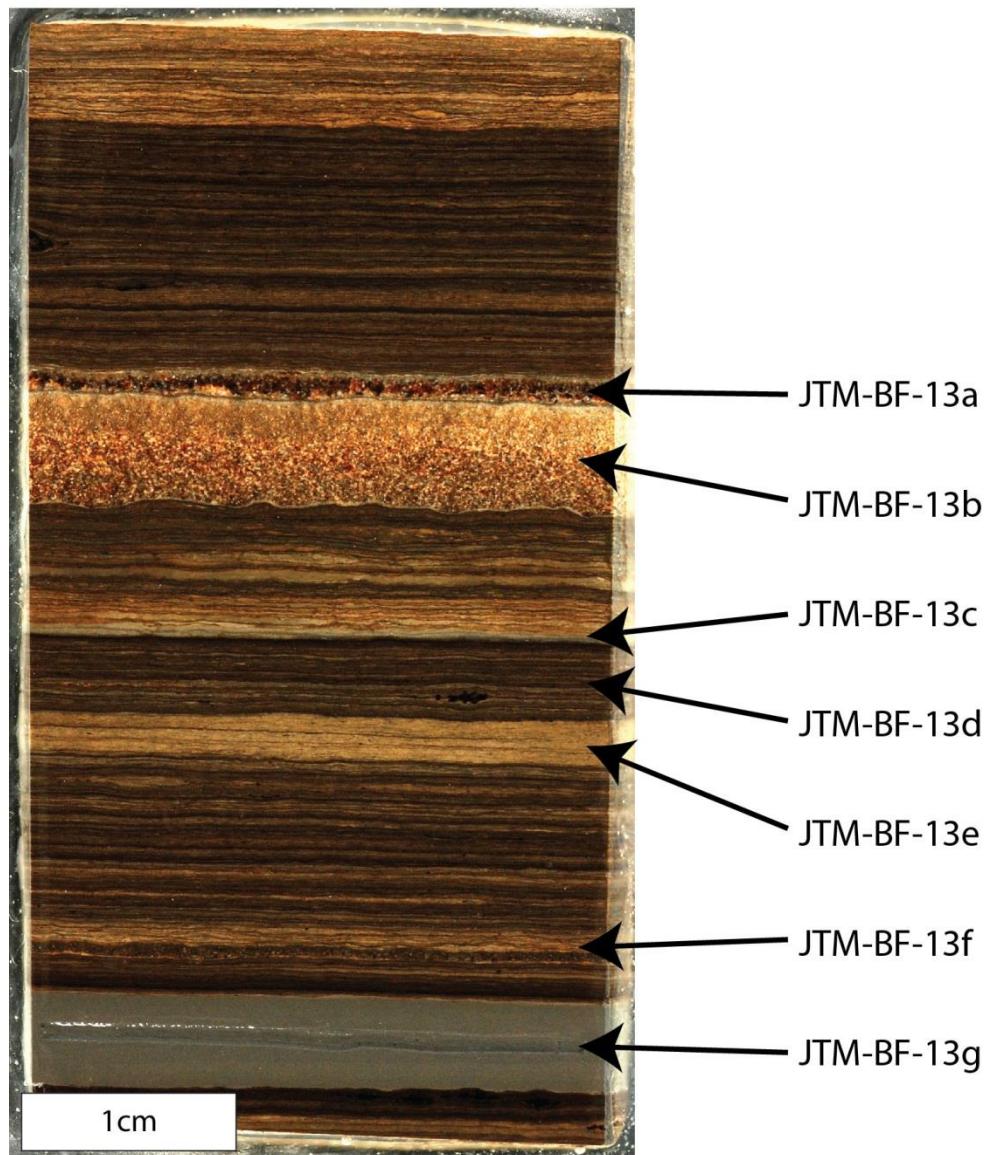


Figure 8. Laminae sample locations and hand sample image of JTM-BF-13, 132.8m.

Sample Depth: 133.4m

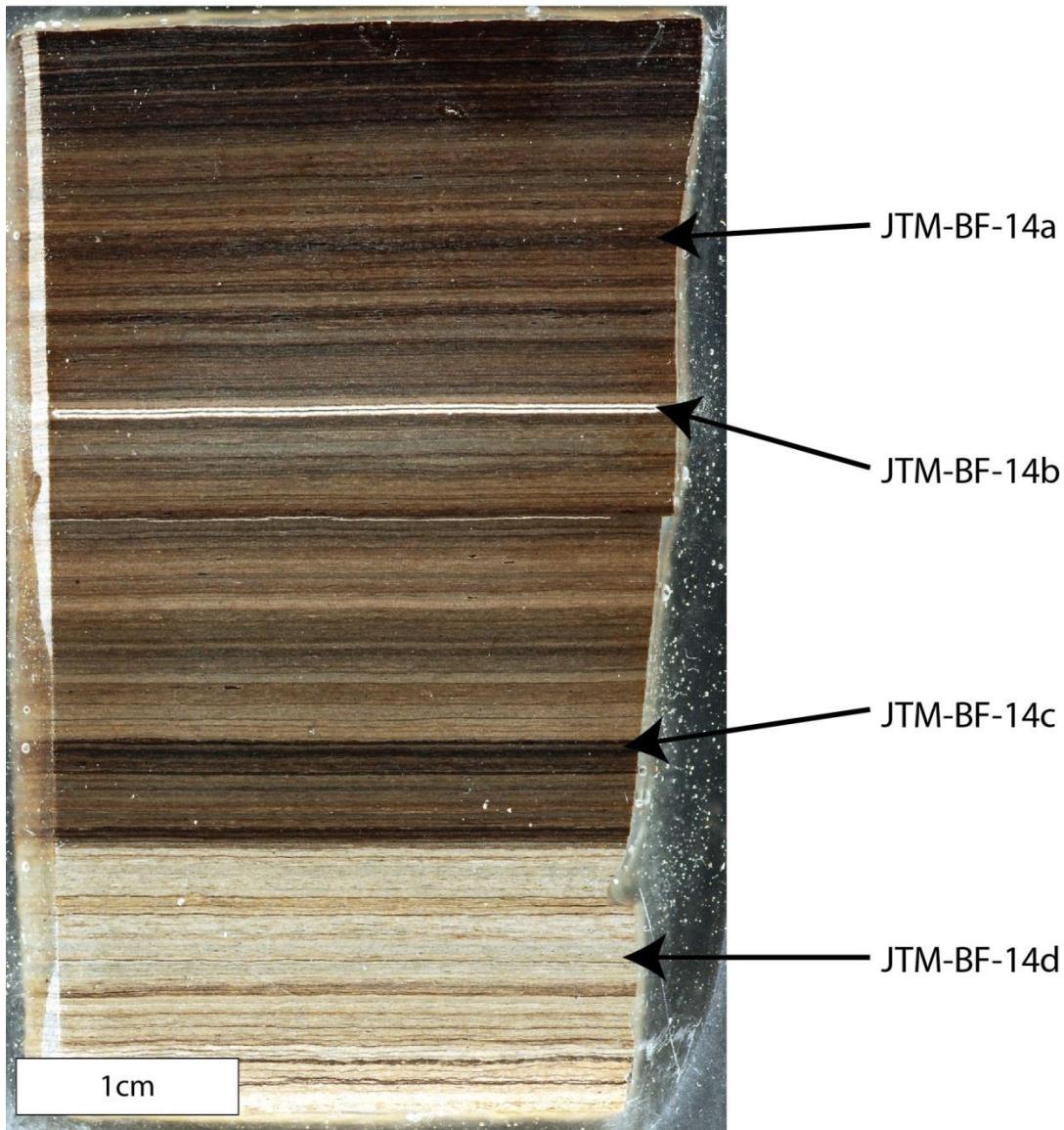


Figure 9. Laminae sample locations and hand sample image of JTM-BF-14, 133.4m.

Sample Depth: 135.3m

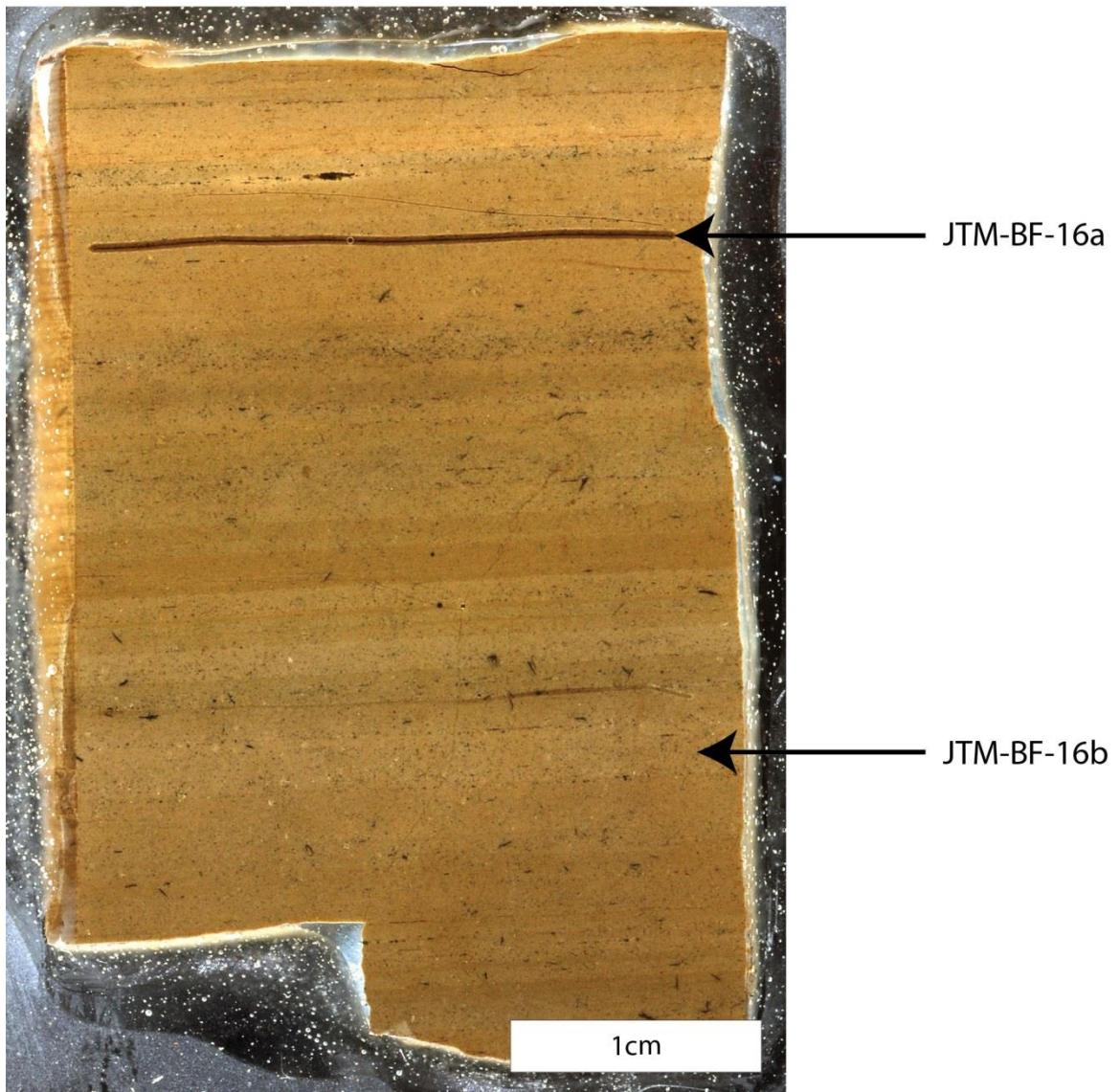


Figure 10. Laminae sample locations and hand sample image of JTM-BF-16, 135.3m.

Sample Depth: 136.0m

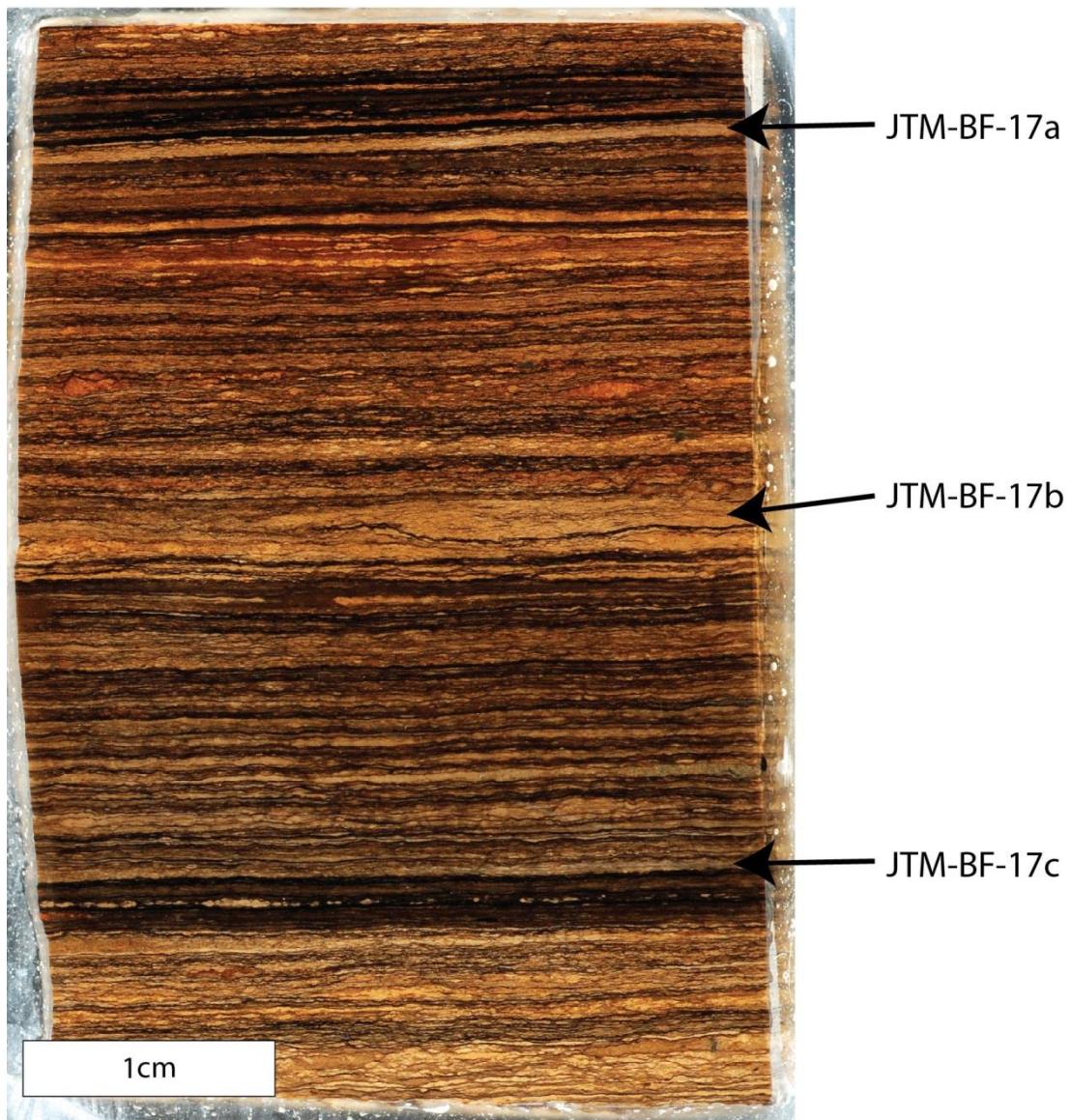


Figure 11. Laminae sample locations and hand sample image of JTM-BF-17, 136.0m.

Sample Depth: 137.1m

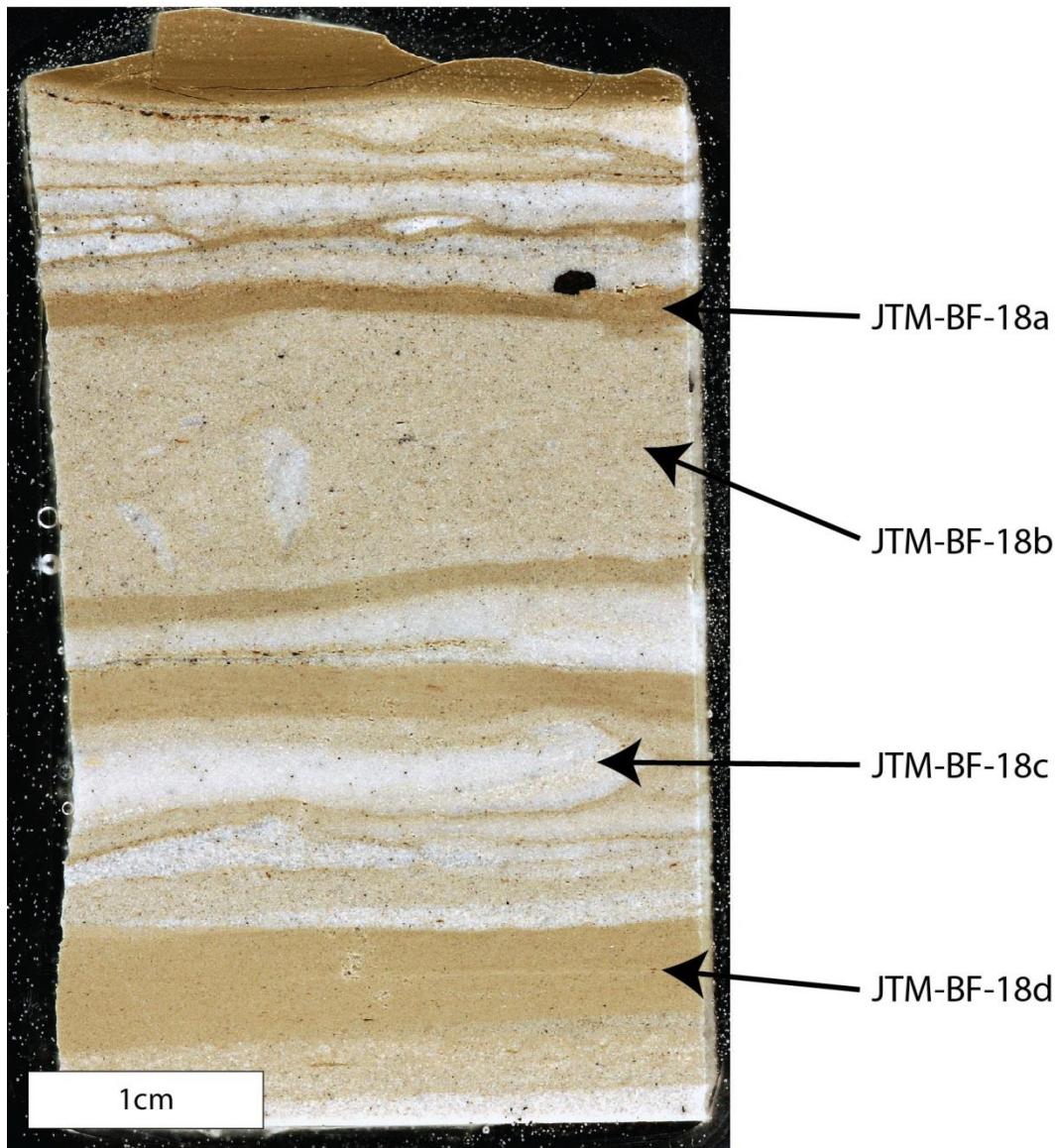


Figure 12. Laminae sample locations and hand sample image of JTM-BF-18, 132.8m.

Sample Depth: 138.2m

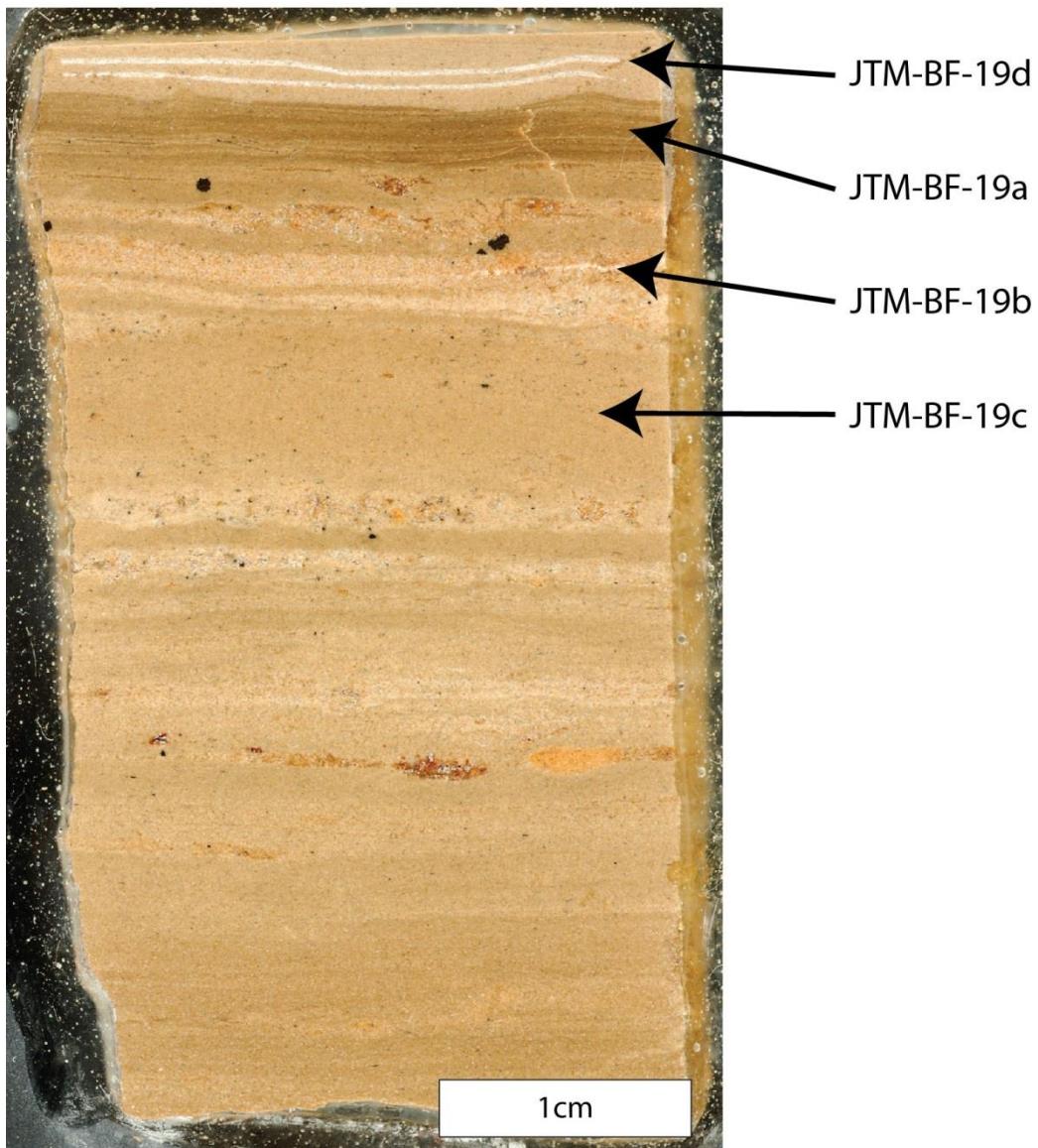


Figure 13. Laminae sample locations and hand sample image of JTM-BF-19, 138.2m.

Sample Depth: 138.2m

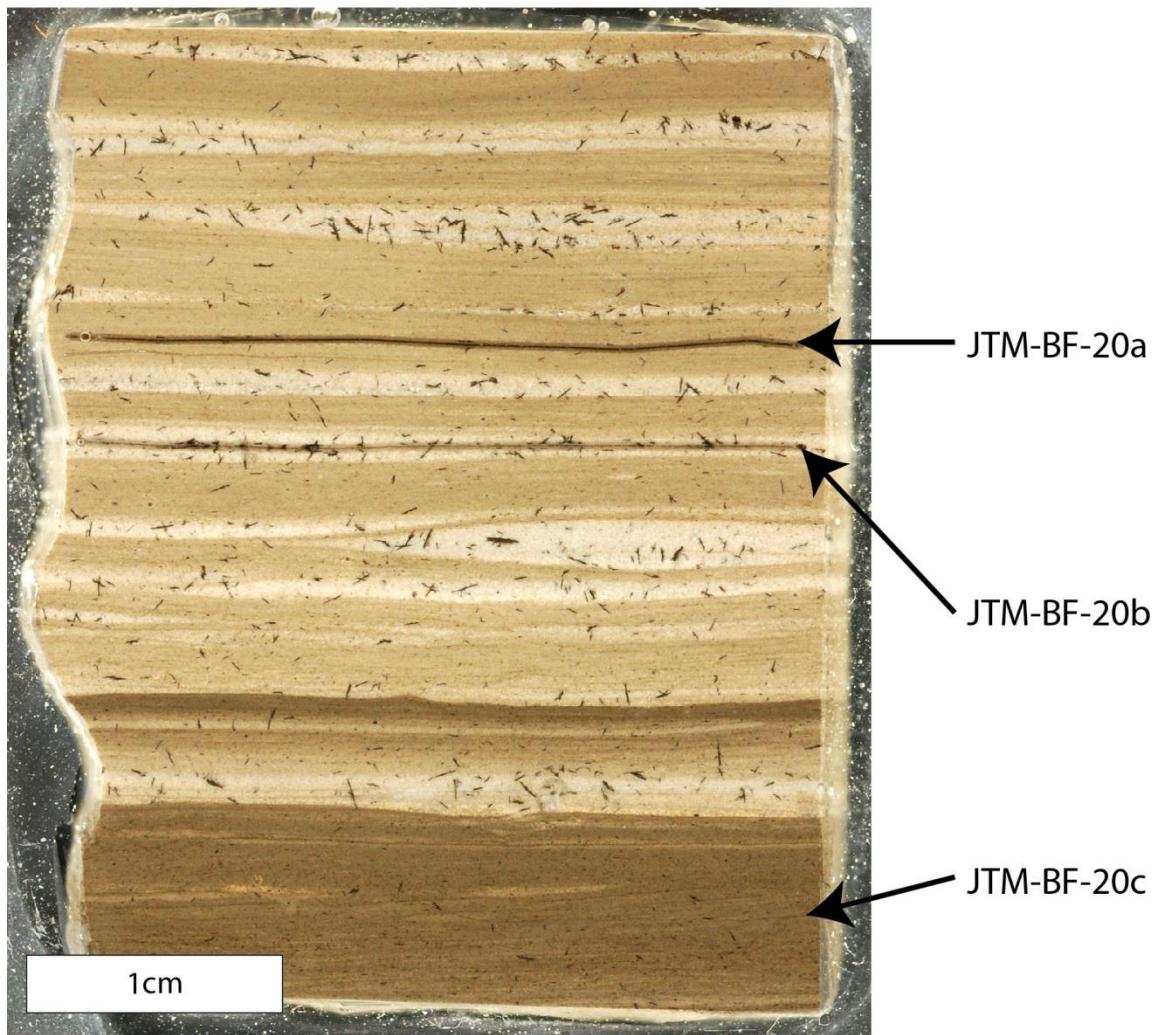


Figure 14. Laminae sample locations and hand sample image of JTM-BF-20, 139.9m.

Sample Depth: 141.3m

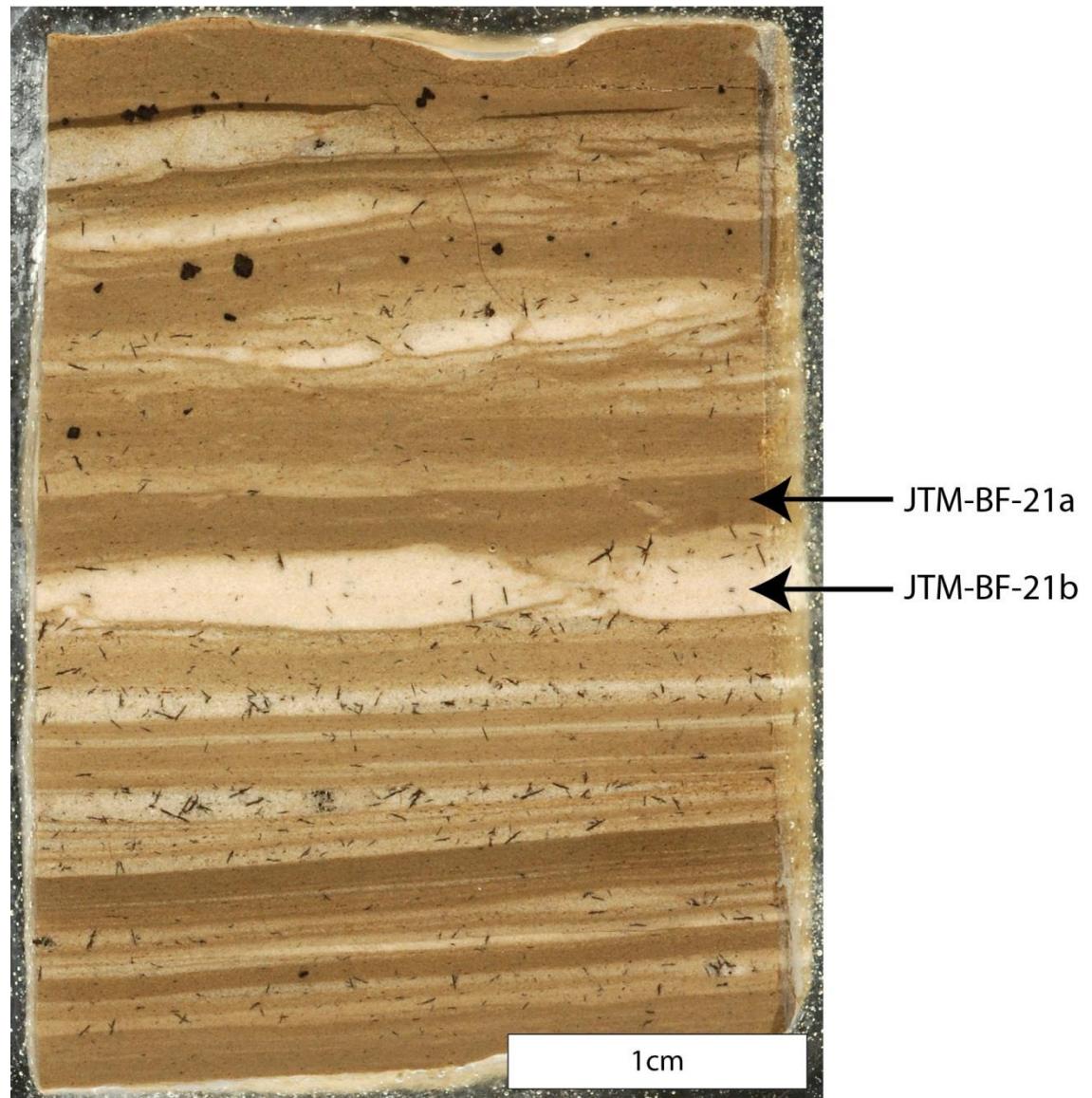


Figure 15. Laminae sample locations and hand sample image of JTM-BF-21, 141.3m.

Sample Depth: 142.0m

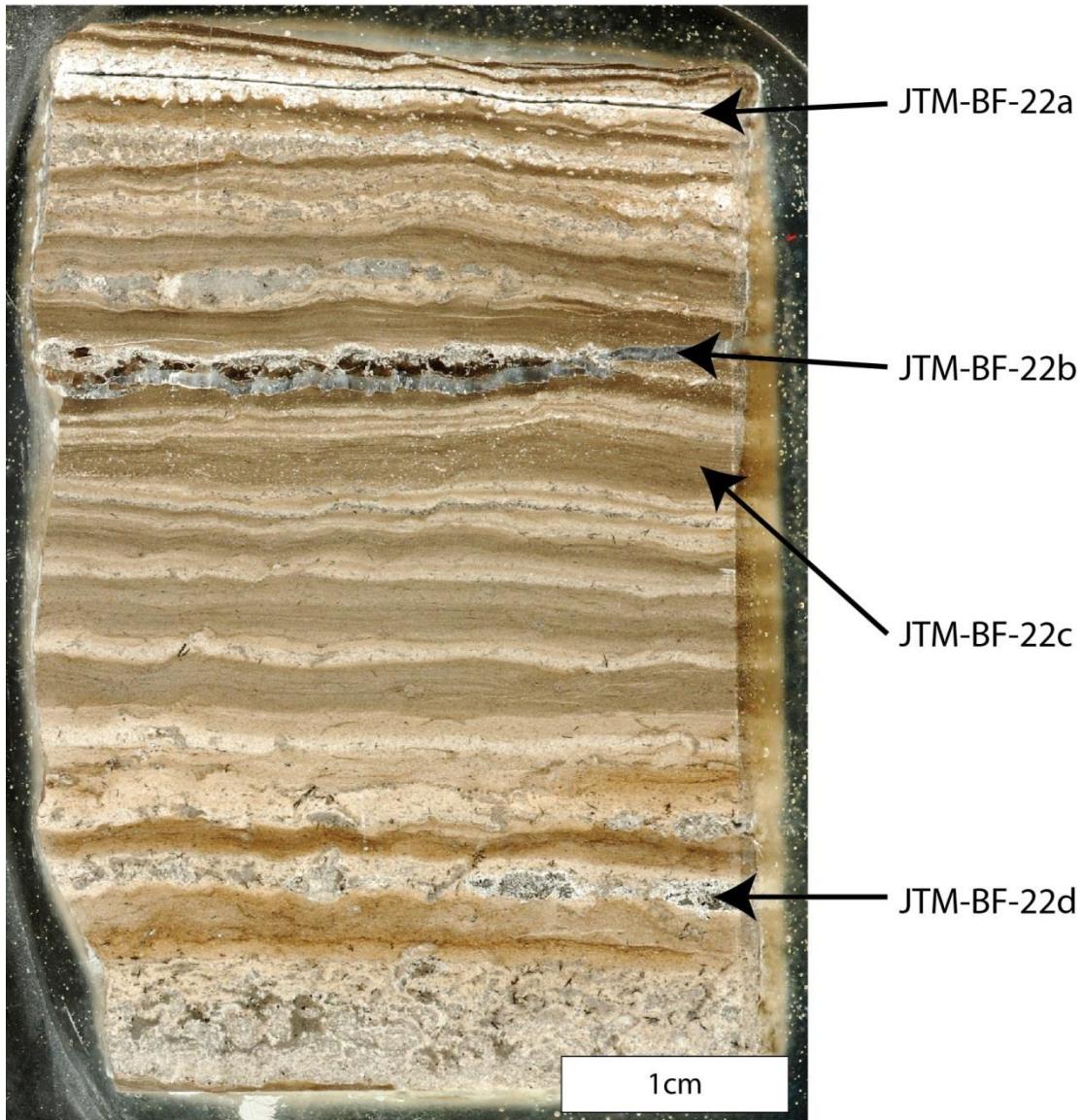


Figure 16. Laminae sample locations and hand sample image of JTM-BF-22, 142.0m.

Sample Depth: 144.1m

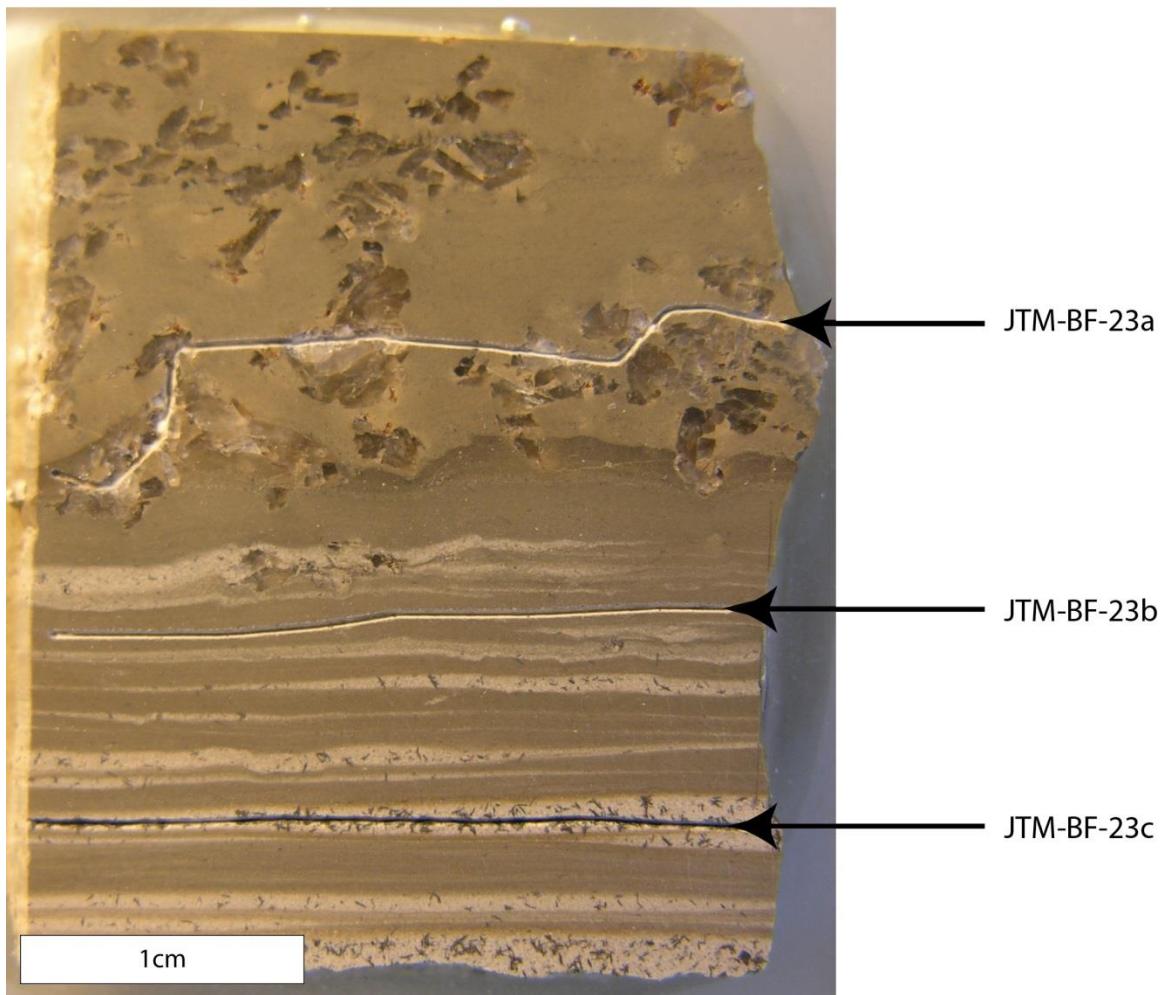


Figure 17. Laminae sample locations and hand sample image of JTM-BF-23, 144.1m.

Sample Depth: 146.6m

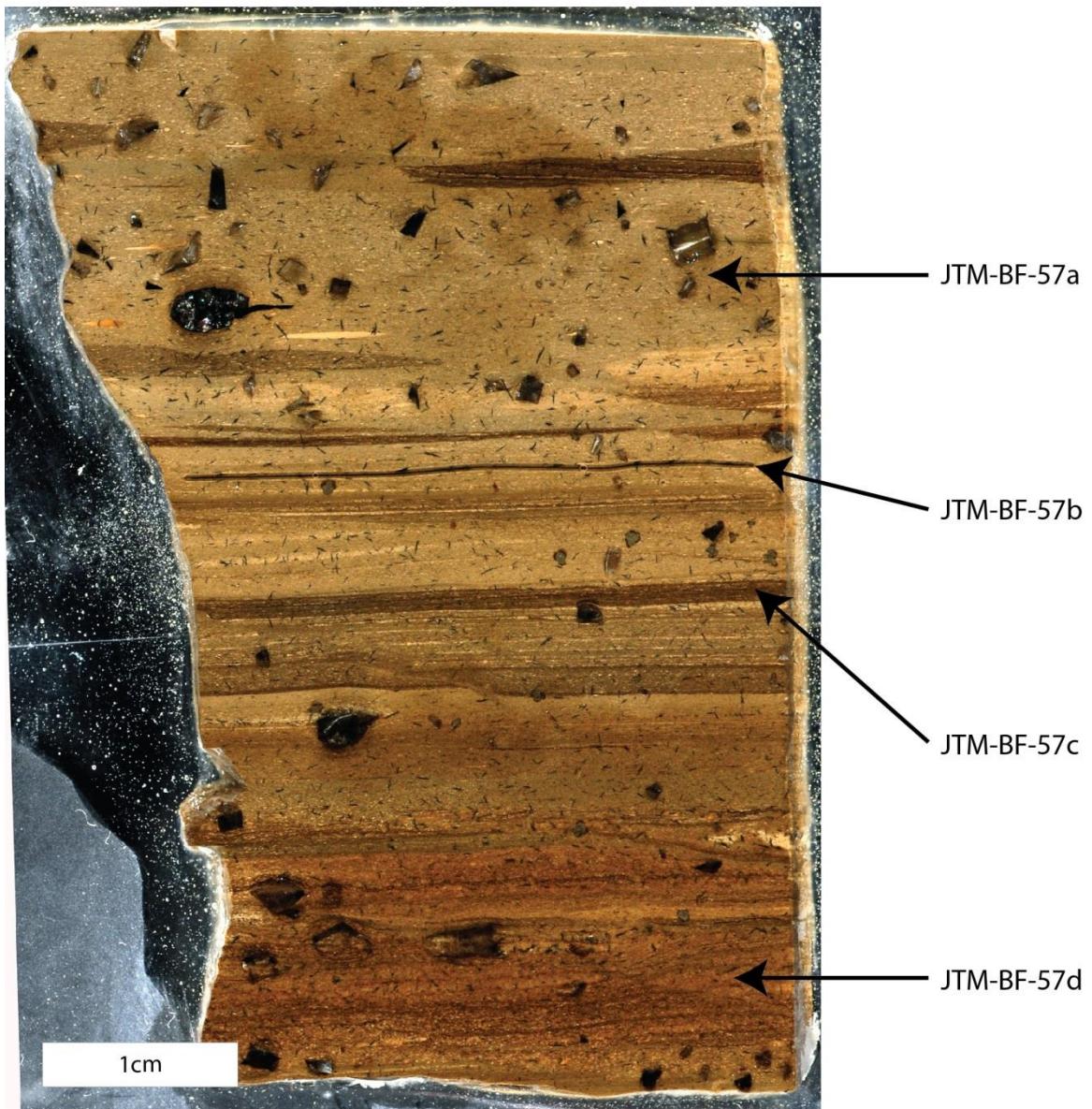


Figure 18. Laminae sample locations and hand sample image of JTM-BF-24, 146.6m.

Sample Depth: 153.7m

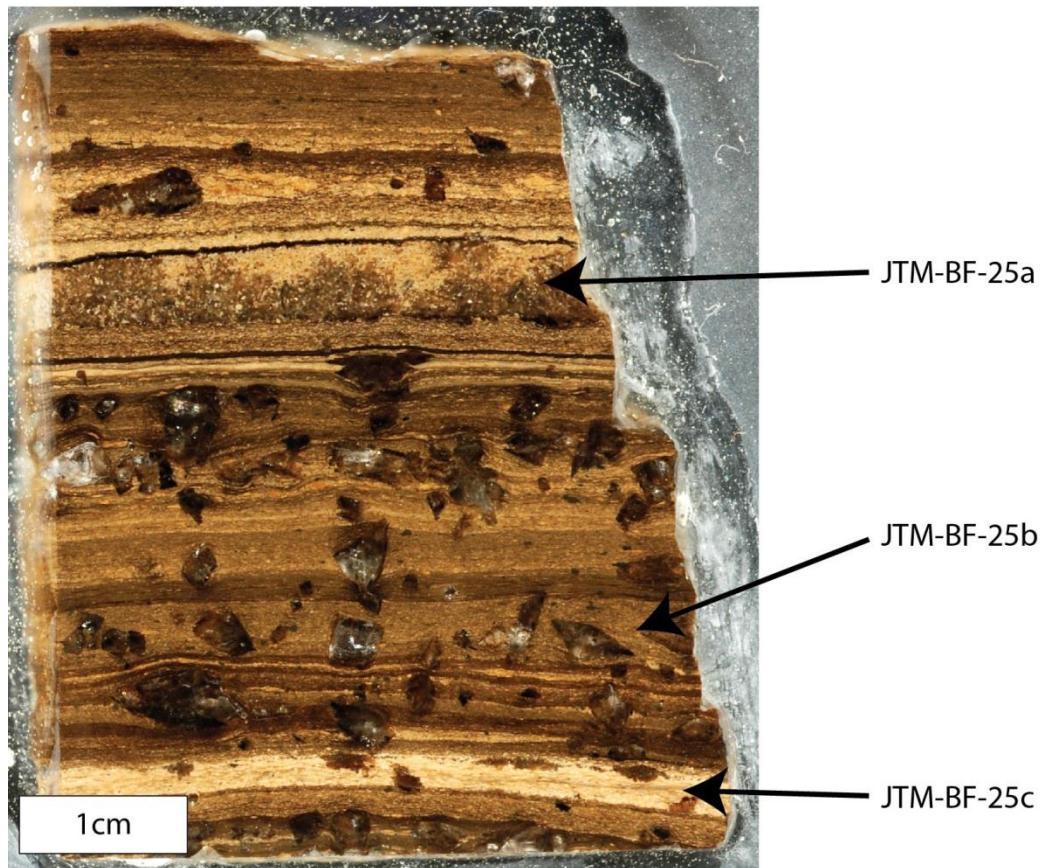


Figure 19. Laminae sample locations and hand sample image of JTM-BF-25, 153.7m.

Sample Depth: 154.0m

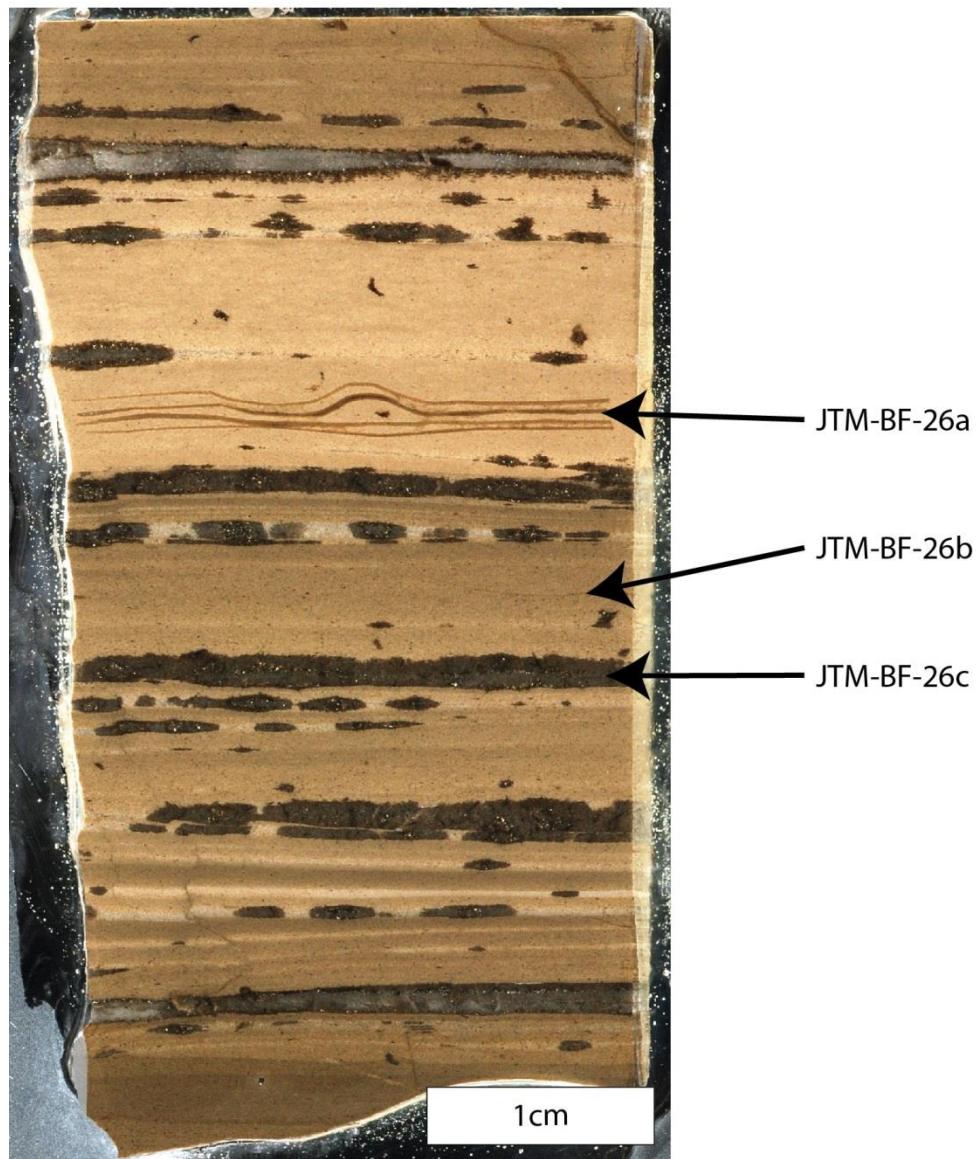


Figure 20. Laminae sample locations and hand sample image of JTM-BF-26, 154.0m.

Sample Depth: 168.0m

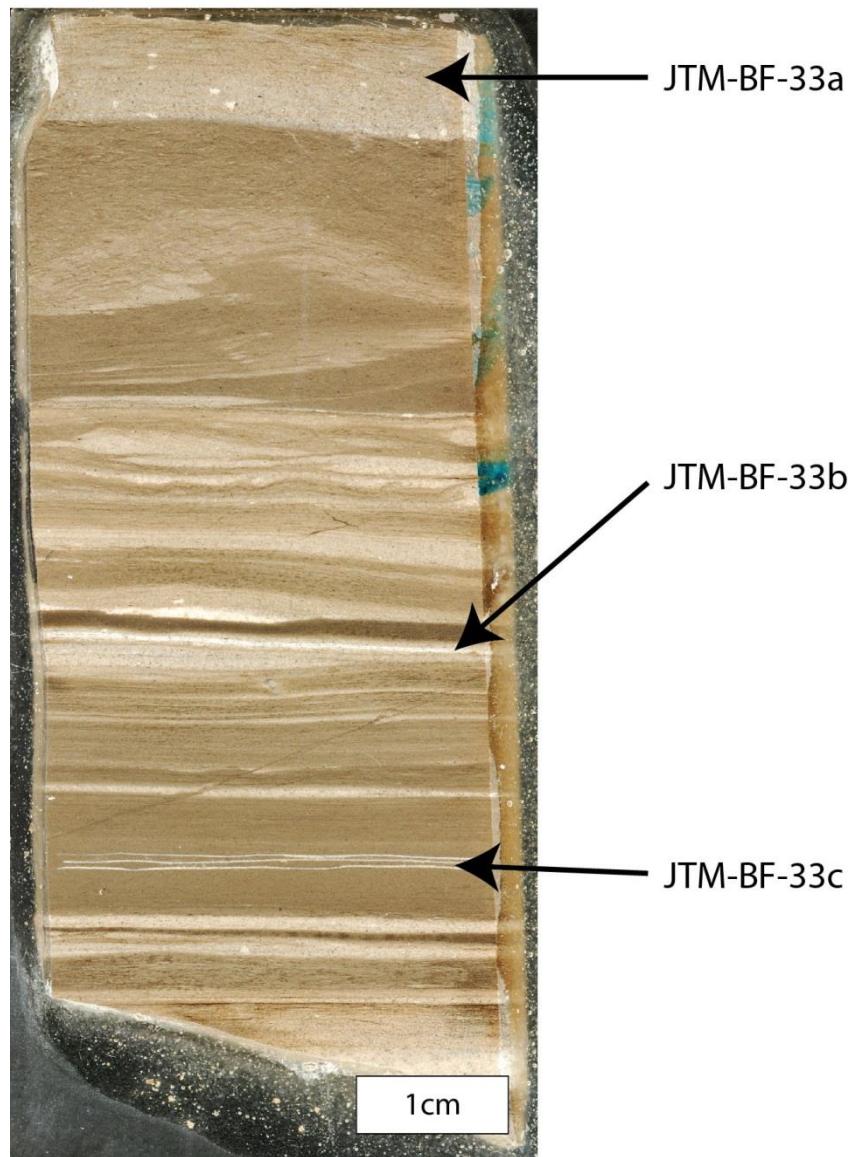


Figure 21. Laminae sample locations and hand sample image of JTM-BF-33, 168.0m.

Sample Depth: 168.3m

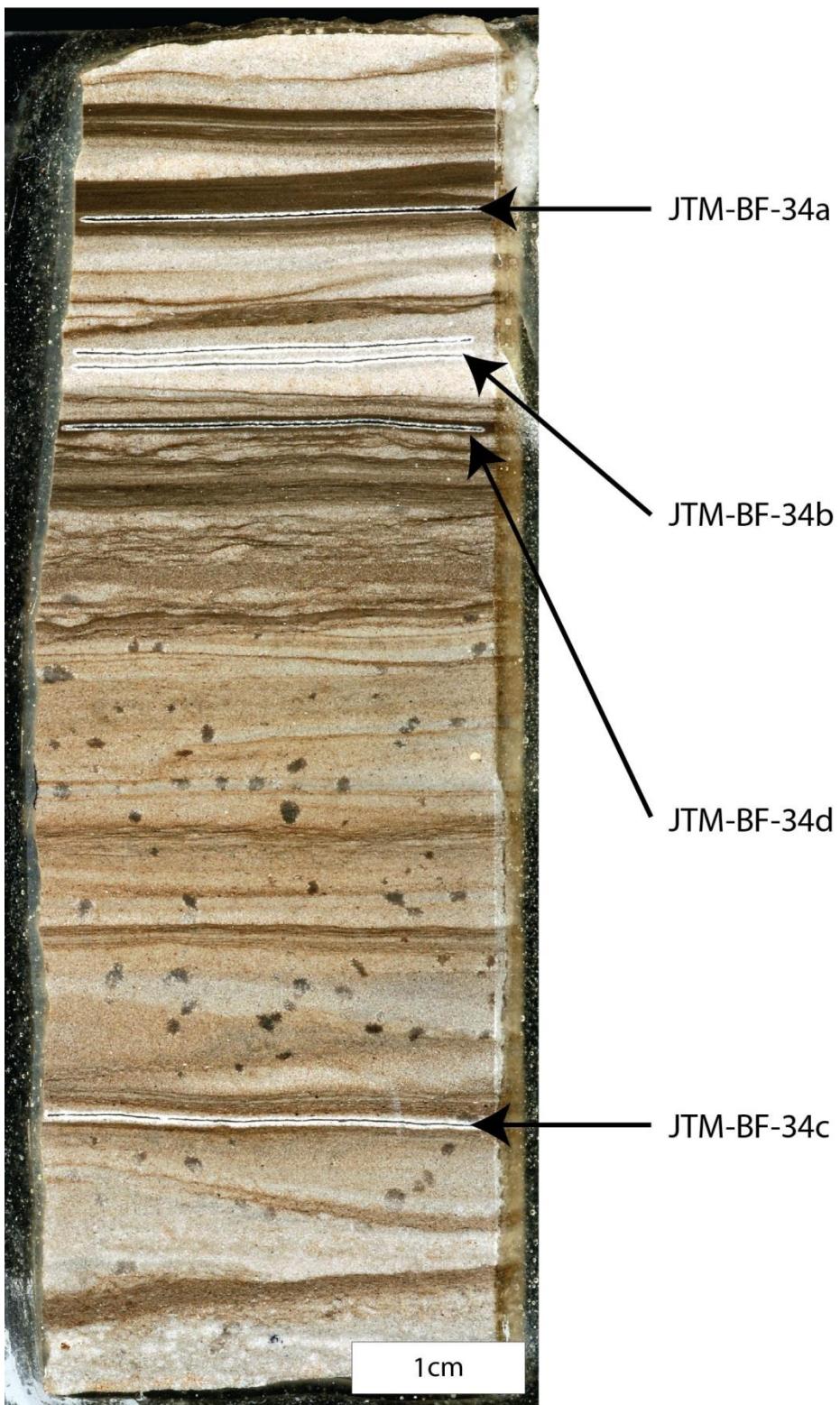


Figure 22. Laminae sample locations and hand sample image of JTM-BF-34, 168.2m.

Sample Depth: 168.5m

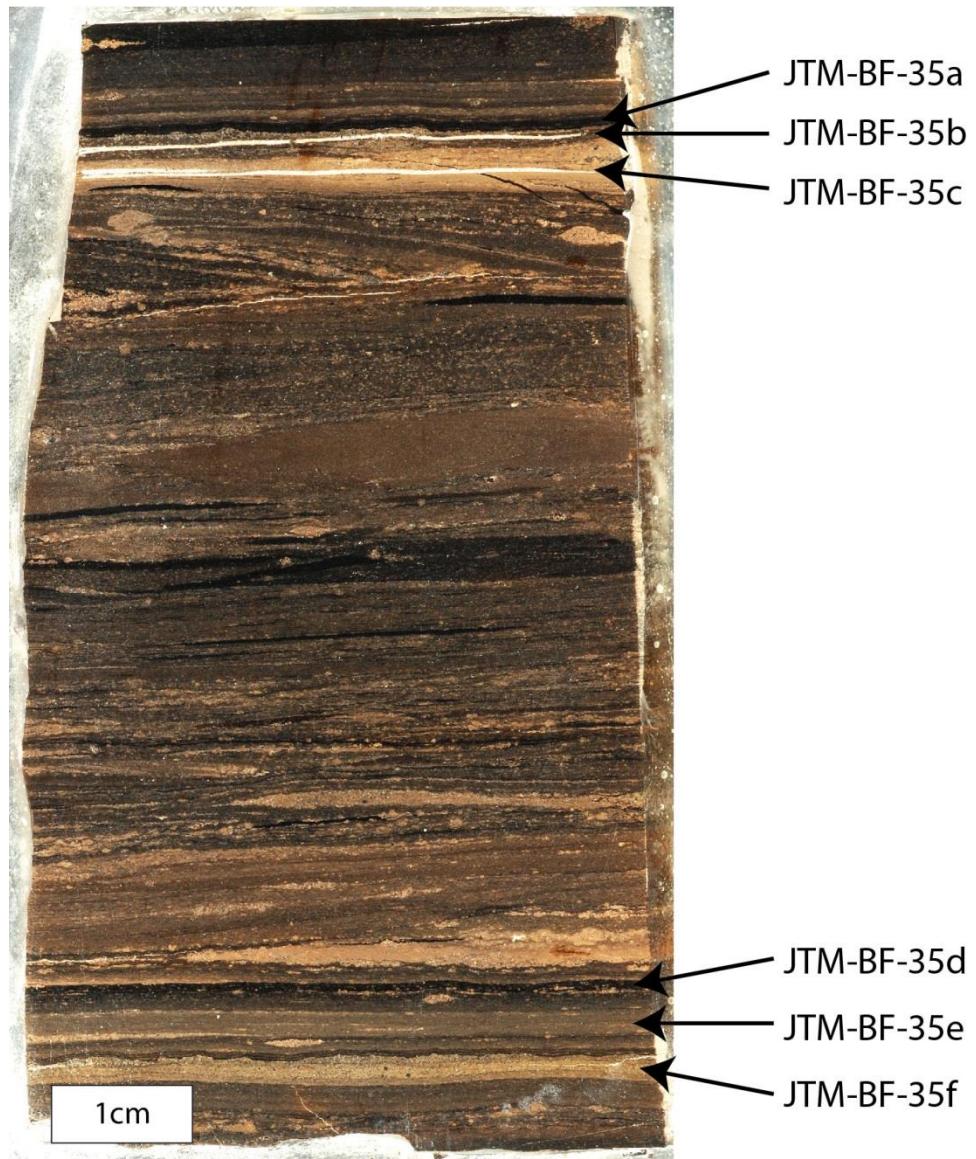


Figure 23. Laminae sample locations and hand sample image of JTM-BF-35, 168.5m.

Sample Depth: 295.6m

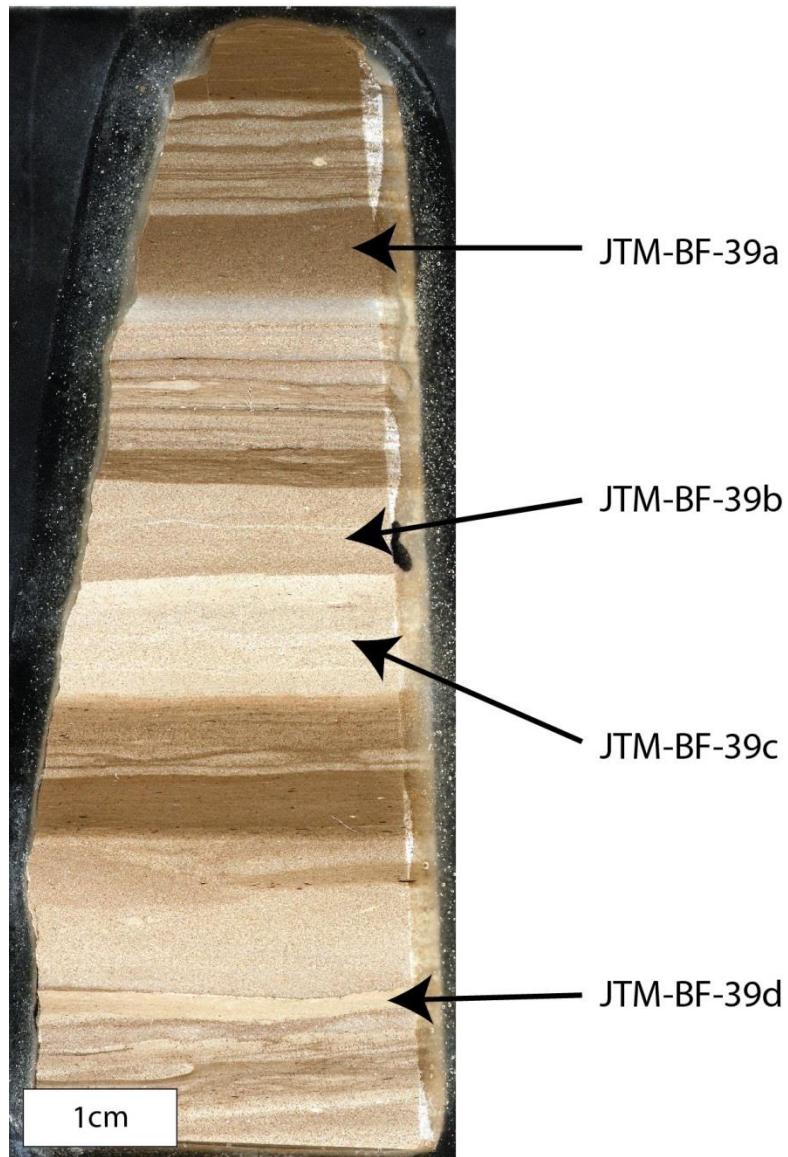


Figure 24. Laminae sample locations and hand sample image of JTM-BF-39, 295.6m.

Sample Depth: 306.9m

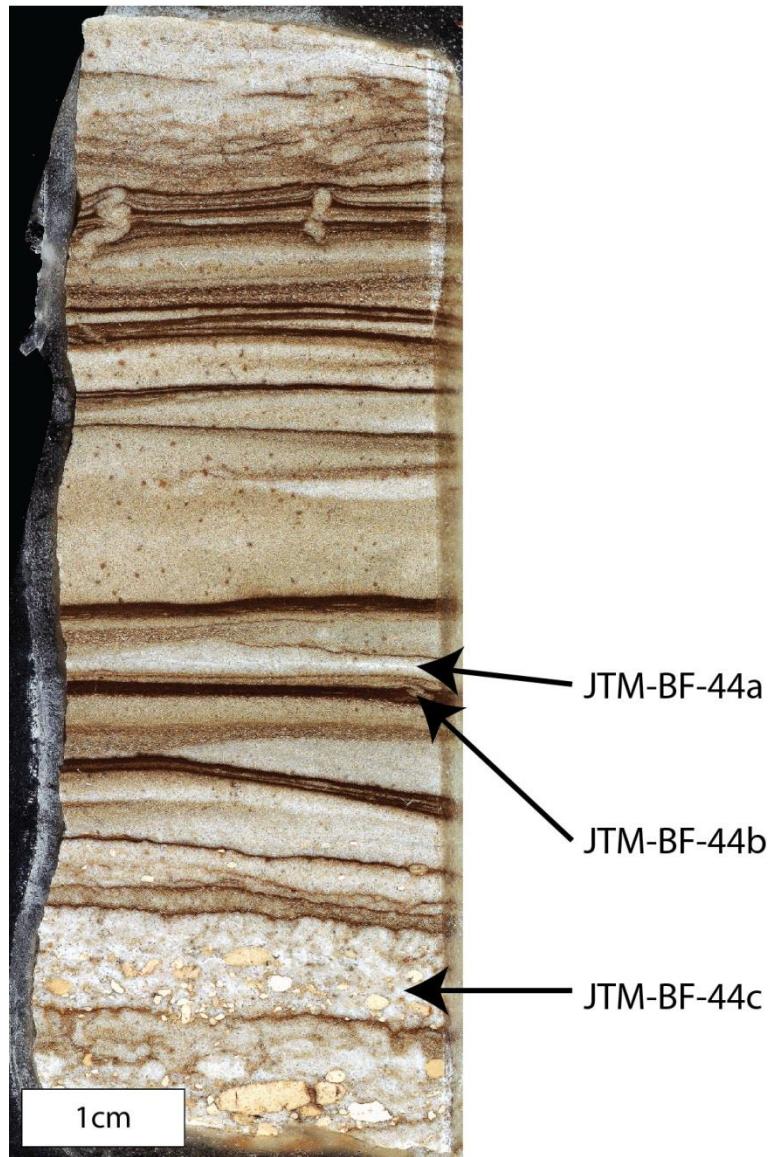


Figure 25. Laminae sample locations and hand sample image of JTM-BF-44, 306.9m.

Sample Depth: 329.5m

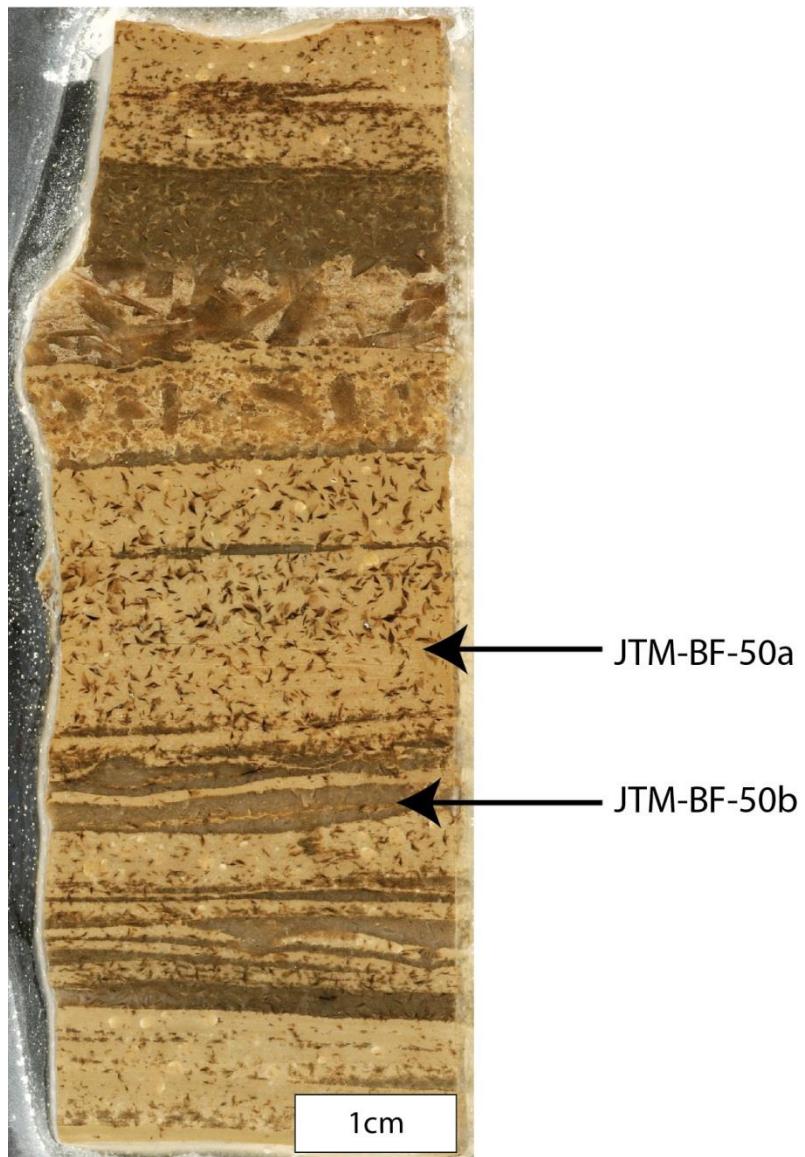


Figure 26. Laminae sample locations and hand sample image of JTM-BF-50, 329.5m.

Sample Depth: 347.9m

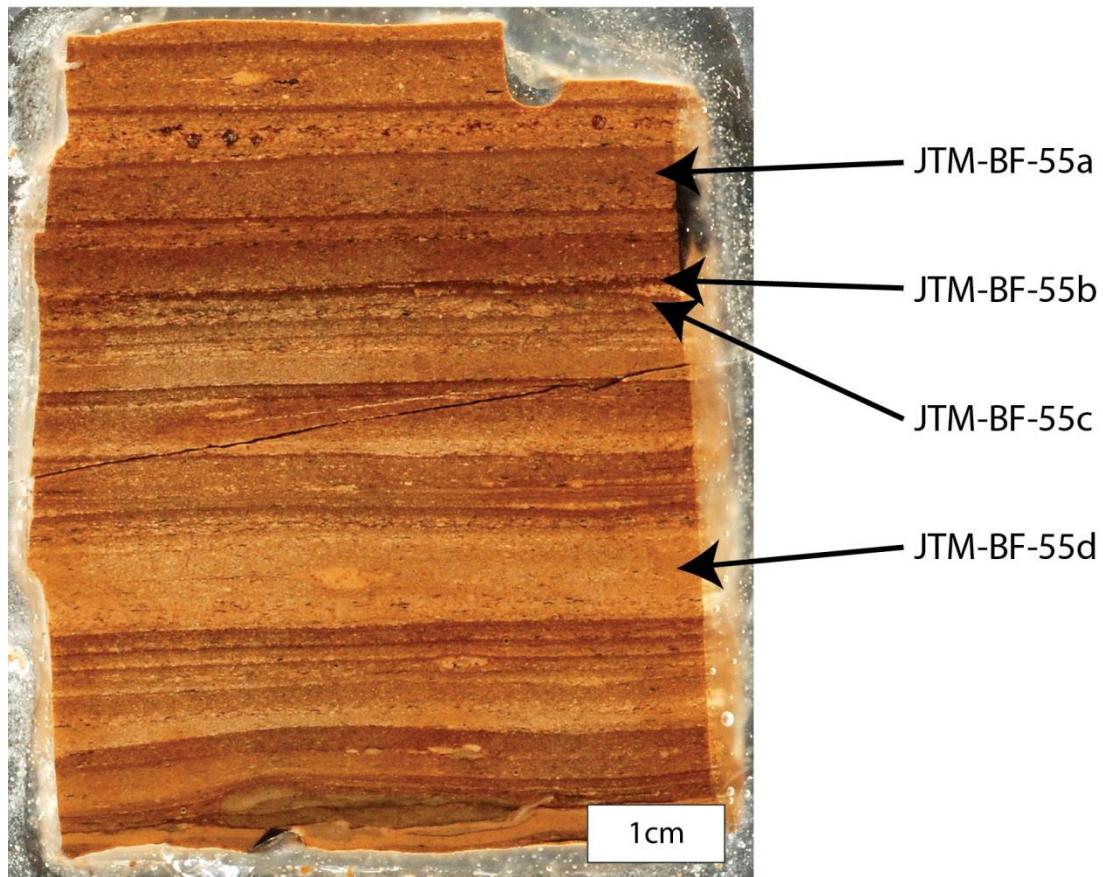


Figure 27. Laminae sample locations and hand sample image of JTM-BF-55, 347.9m.

Sample Depth: 351.7m

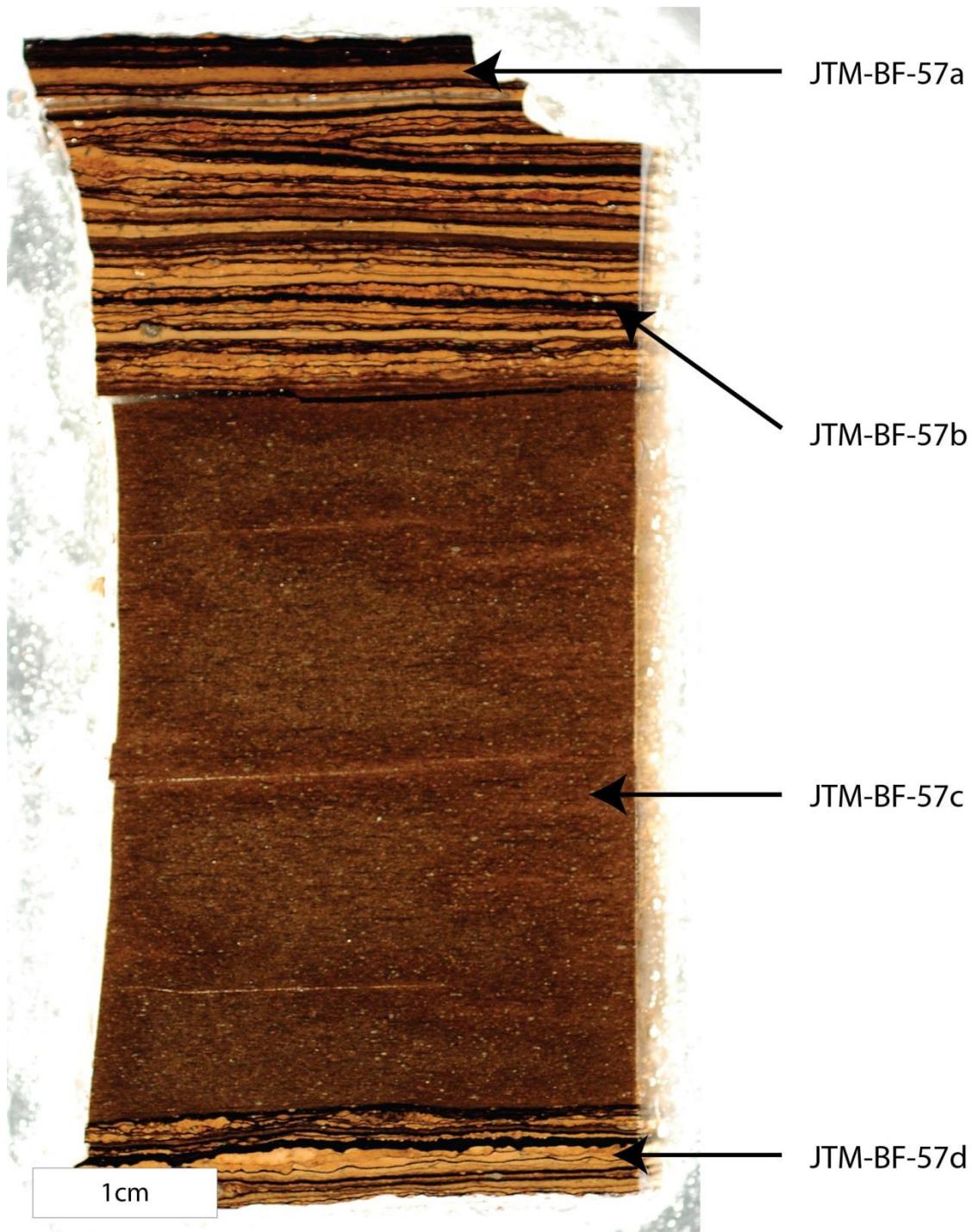


Figure 28. Laminae sample locations and hand sample image of JTM-BF-57, 351.6m.

Sample Depth: 367.0m

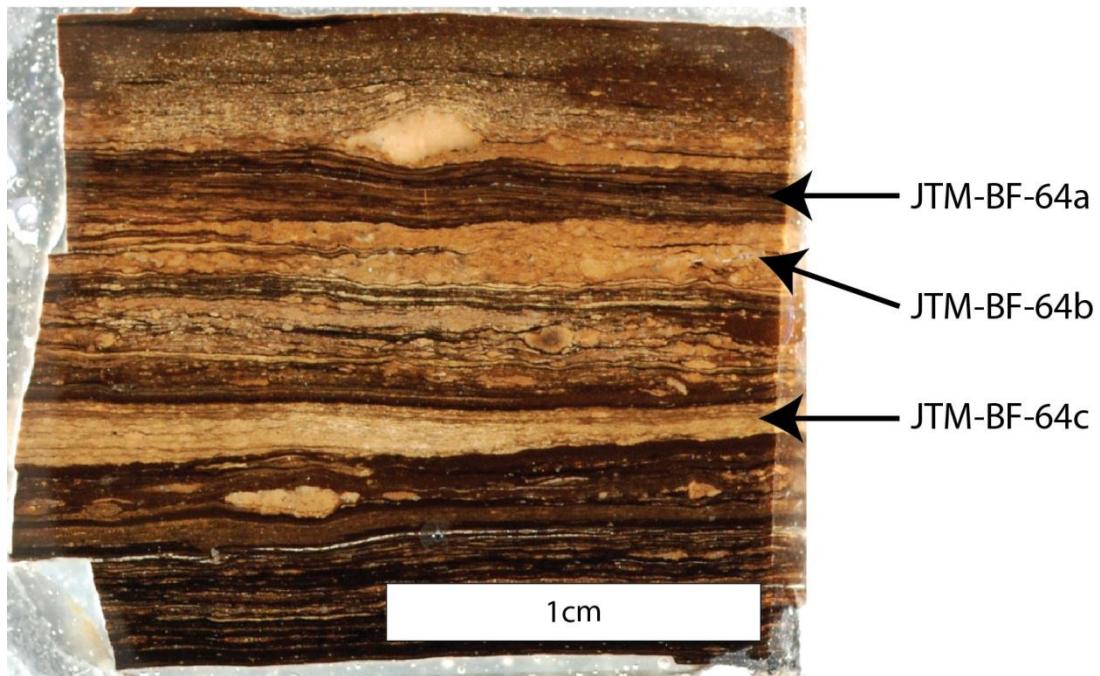


Figure 29. Laminae sample locations and hand sample image of JTM-BF-64, 367.0m.

## Part 2: Shell 23X-2 Core

Sample Depth: 500.6m

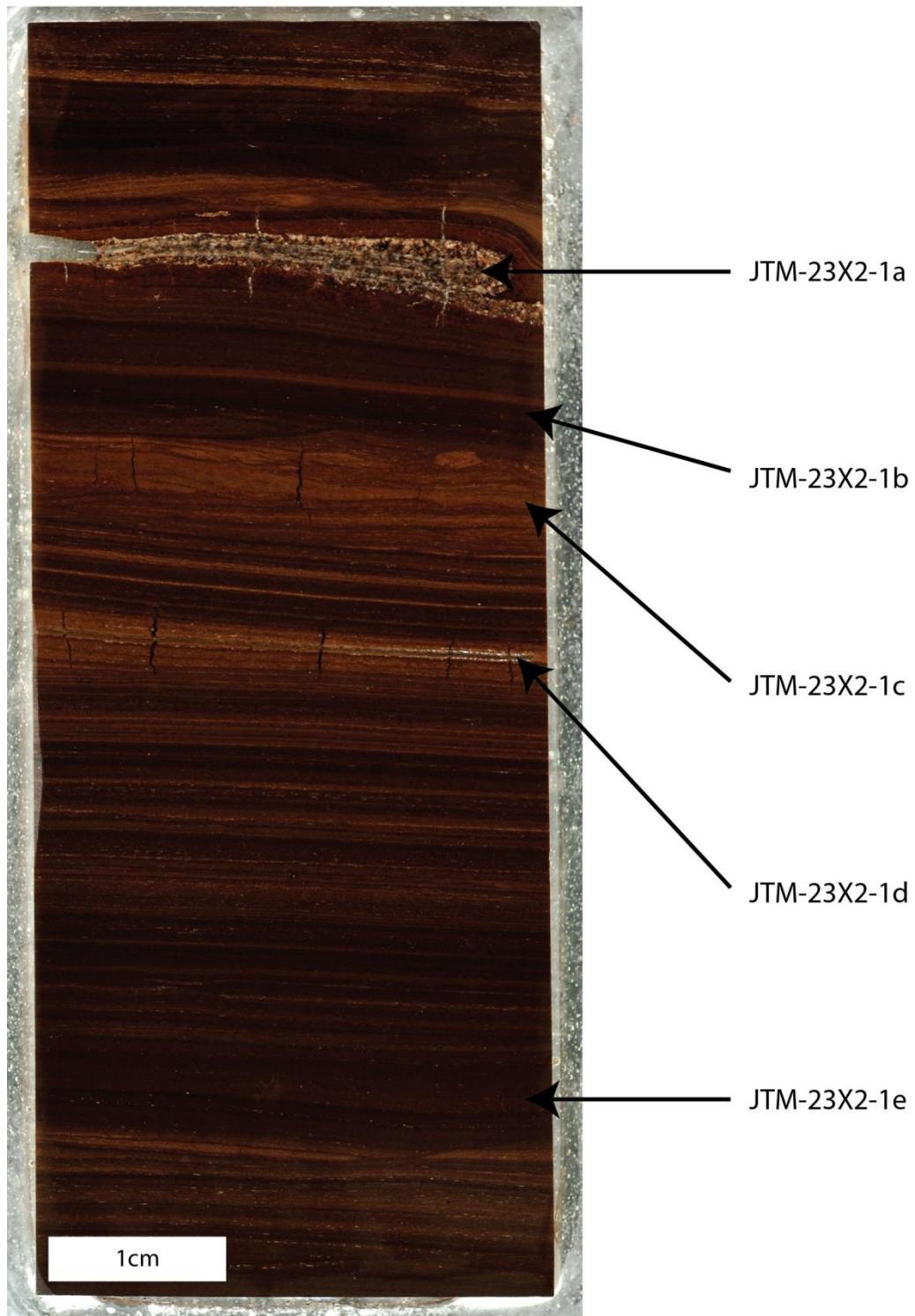


Figure 30. Laminae sample locations and hand sample image of JTM-23X2-1, 43.4m.

Sample Depth: 506.0m

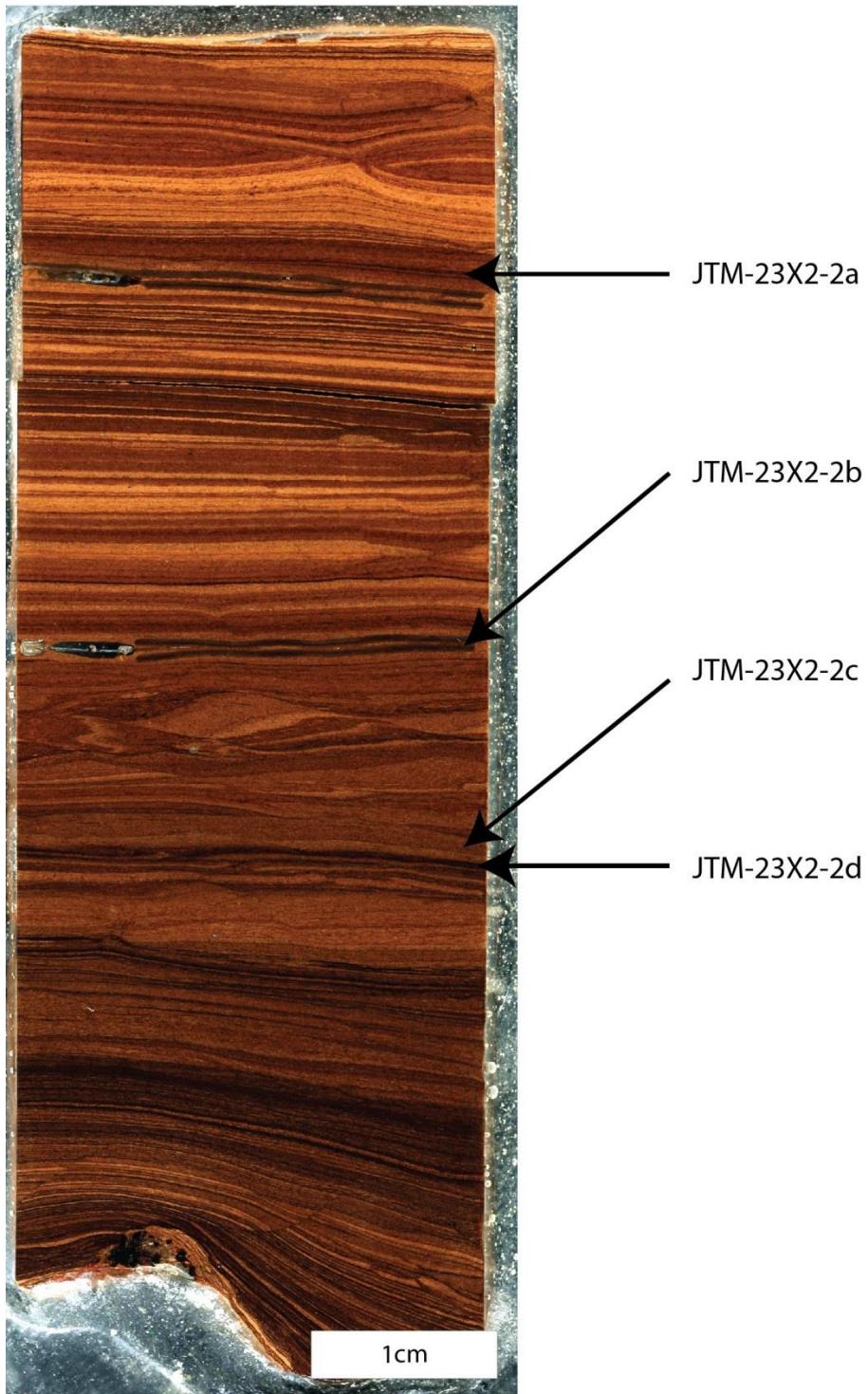


Figure 31. Laminae sample locations and hand sample image of JTM-23X2-2, 506.0m.

Sample Depth: 520.3m



Figure 32. Laminae sample locations and hand sample image of JTM-23X2-4, 520.3m.

Sample Depth: 528.9m

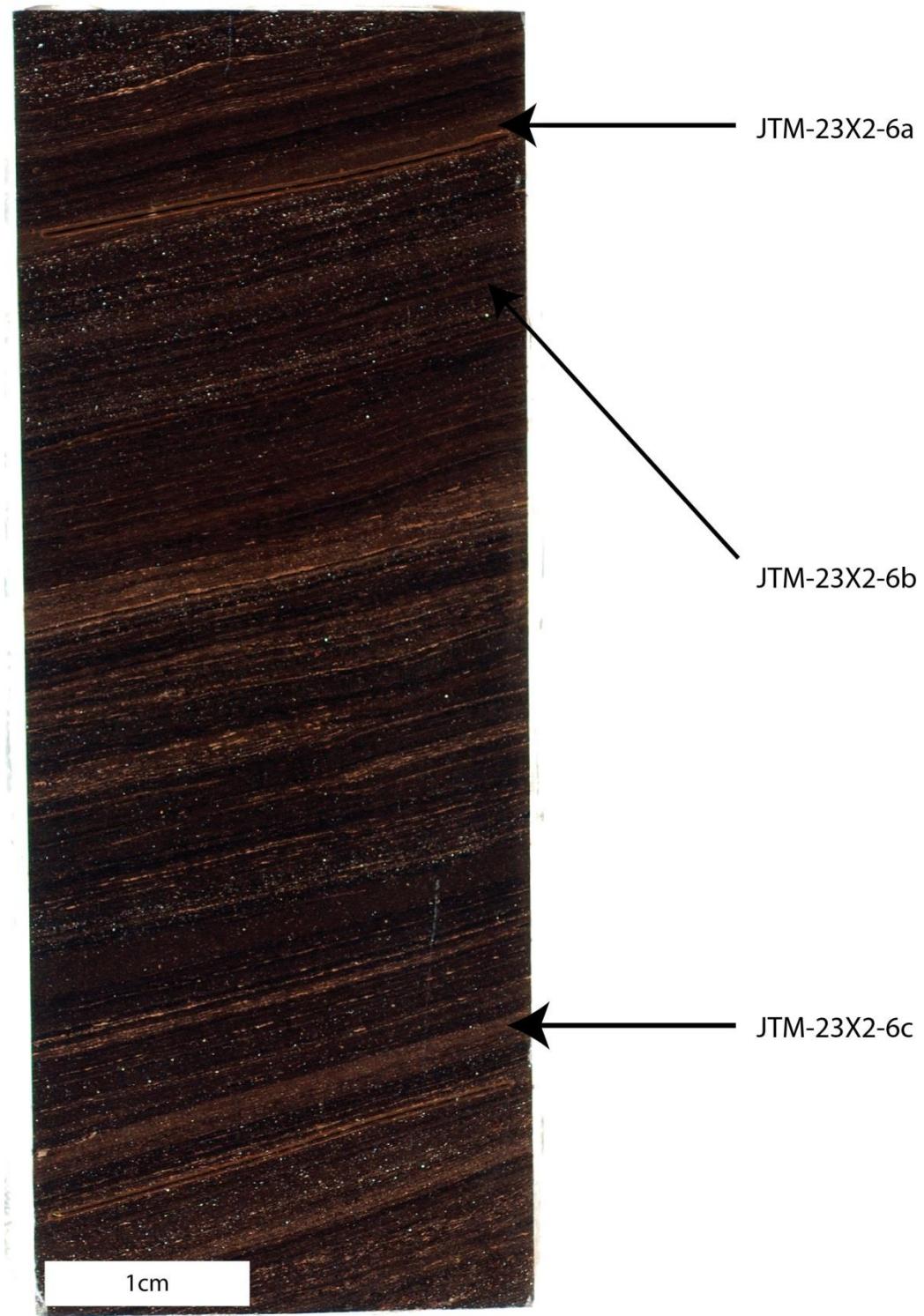


Figure 33. Laminae sample locations and hand sample image of JTM-23X2-6, 528.9m.

Sample Depth: 531.4m



Figure 34. Laminae sample locations and hand sample image of JTM-23X2-8, 531.4m.

Sample Depth: 568.9m

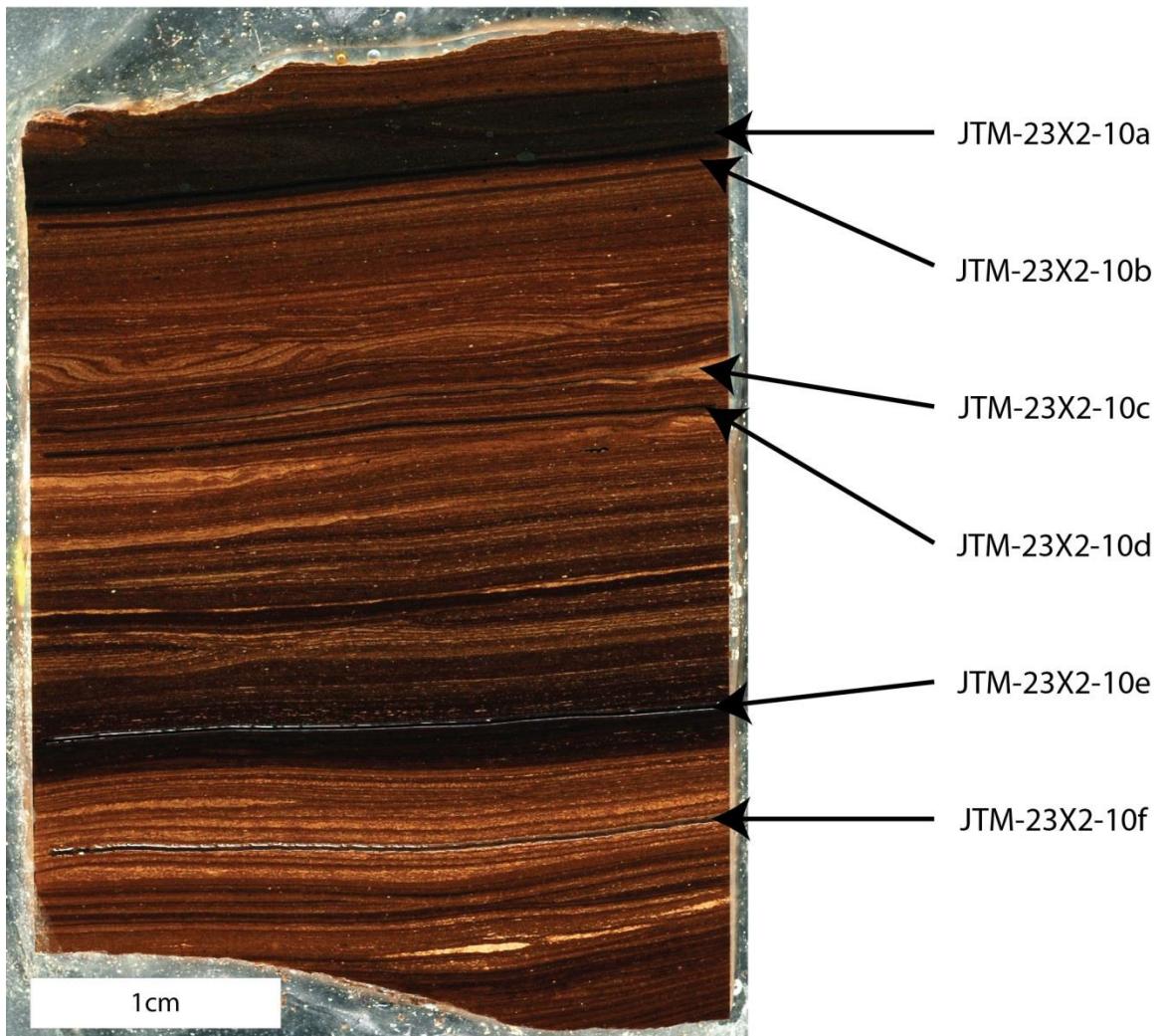


Figure 35. Laminae sample locations and hand sample image of JTM-23X2-10, 568.9m.

Sample Depth: 579.9m

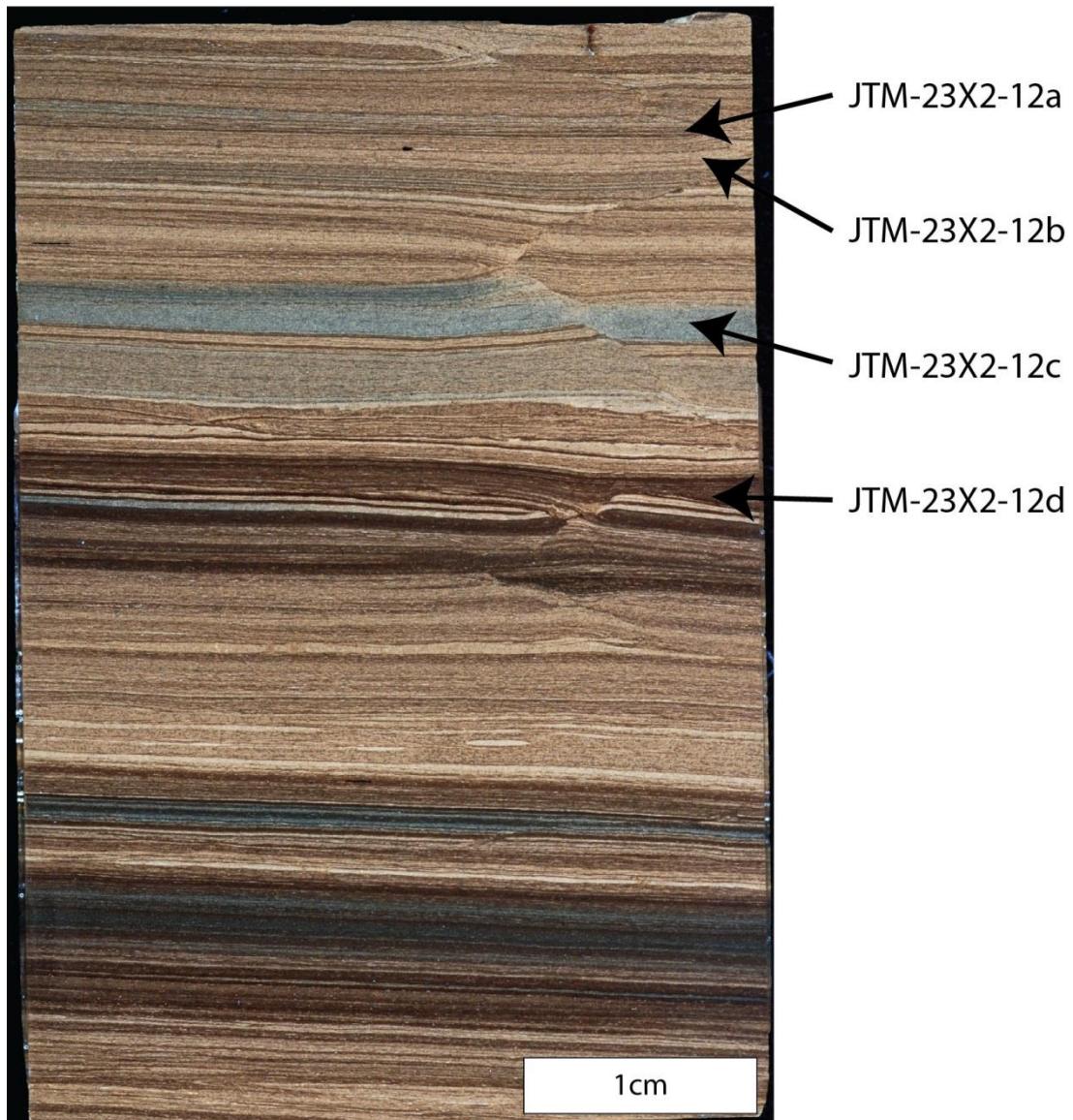


Figure 36. Laminae sample locations and hand sample image of JTM-23X2-12, 579.9m.

Sample Depth: 612.6m

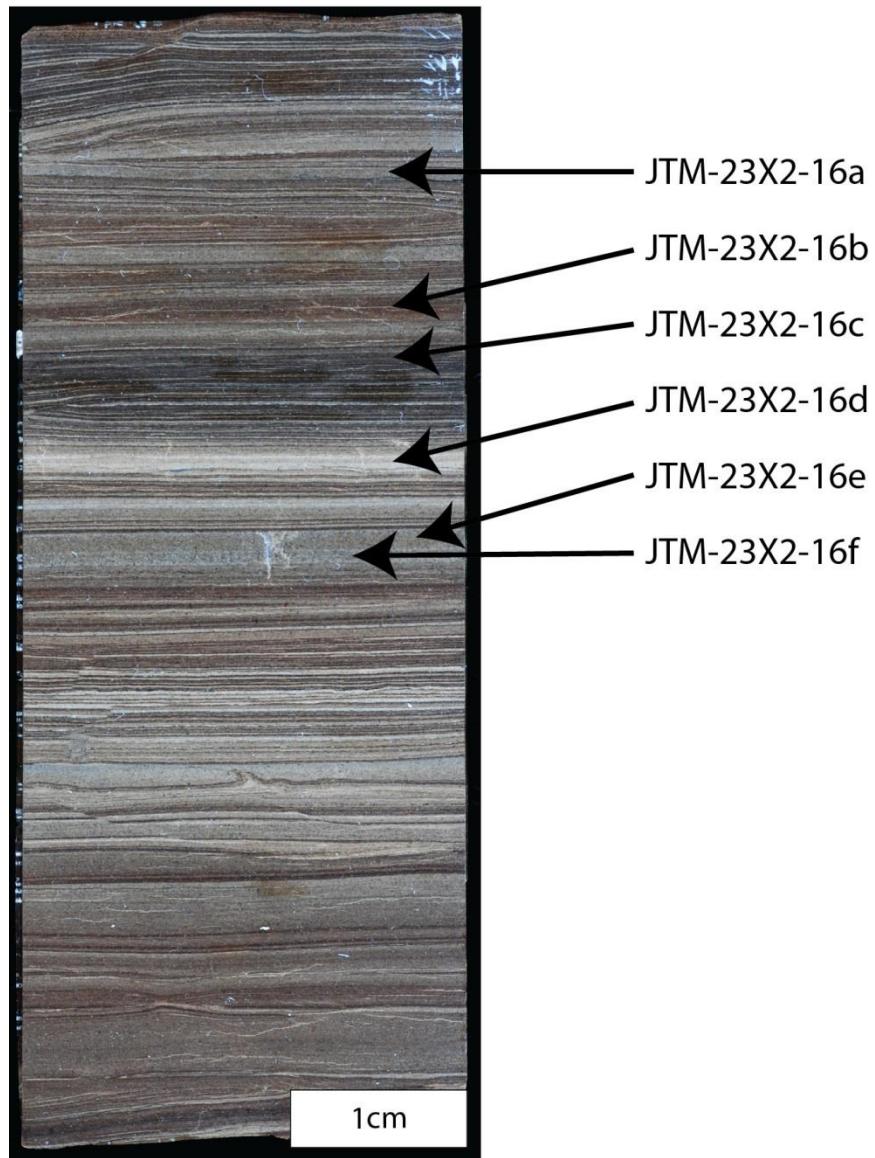


Figure 37. Laminae sample locations and hand sample image of JTM-23X2-16, 612.6m.

Sample Depth: 631.2m

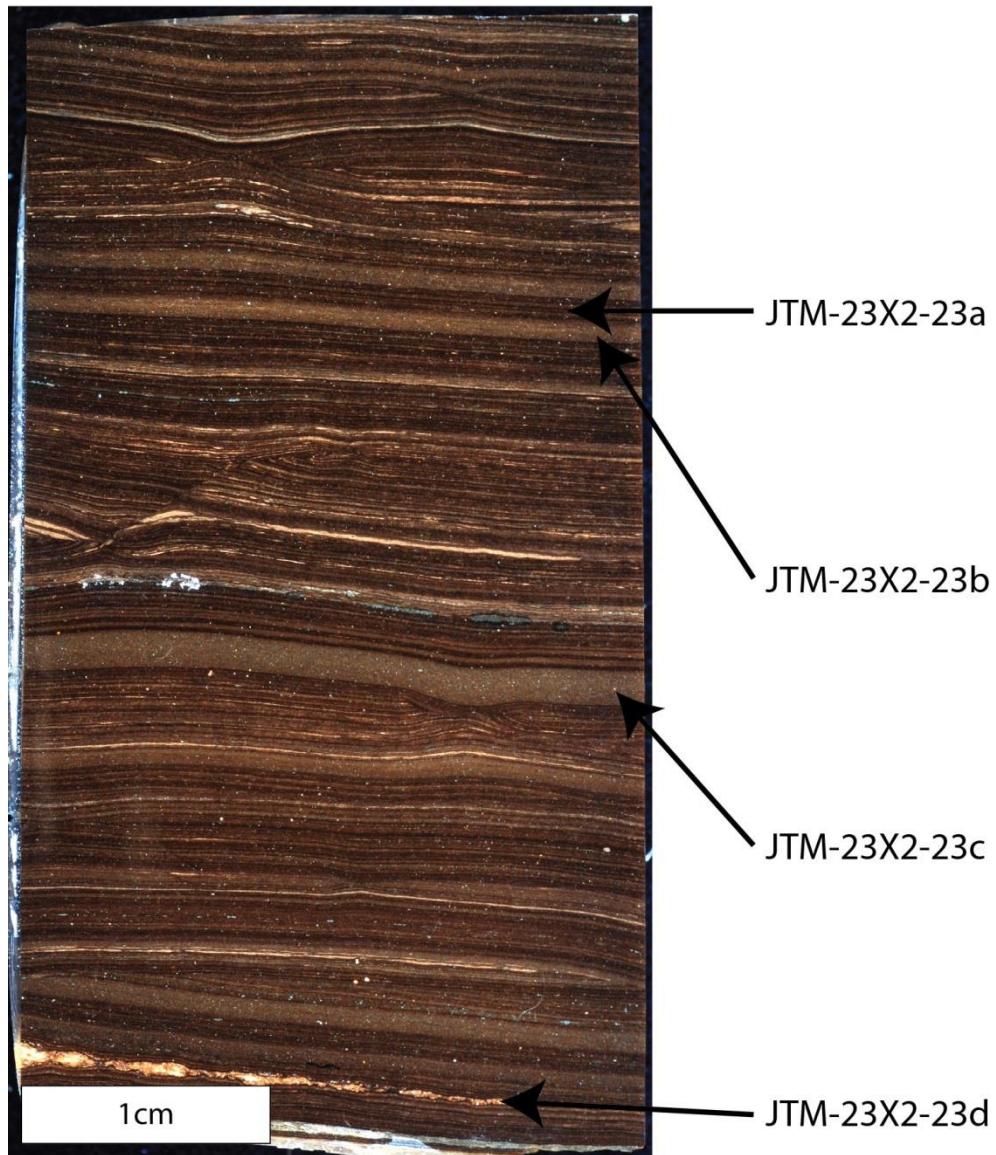


Figure 38. Laminae sample locations and hand sample image of JTM-23X2-23, 631.2m.

Sample Depth: 632.2m

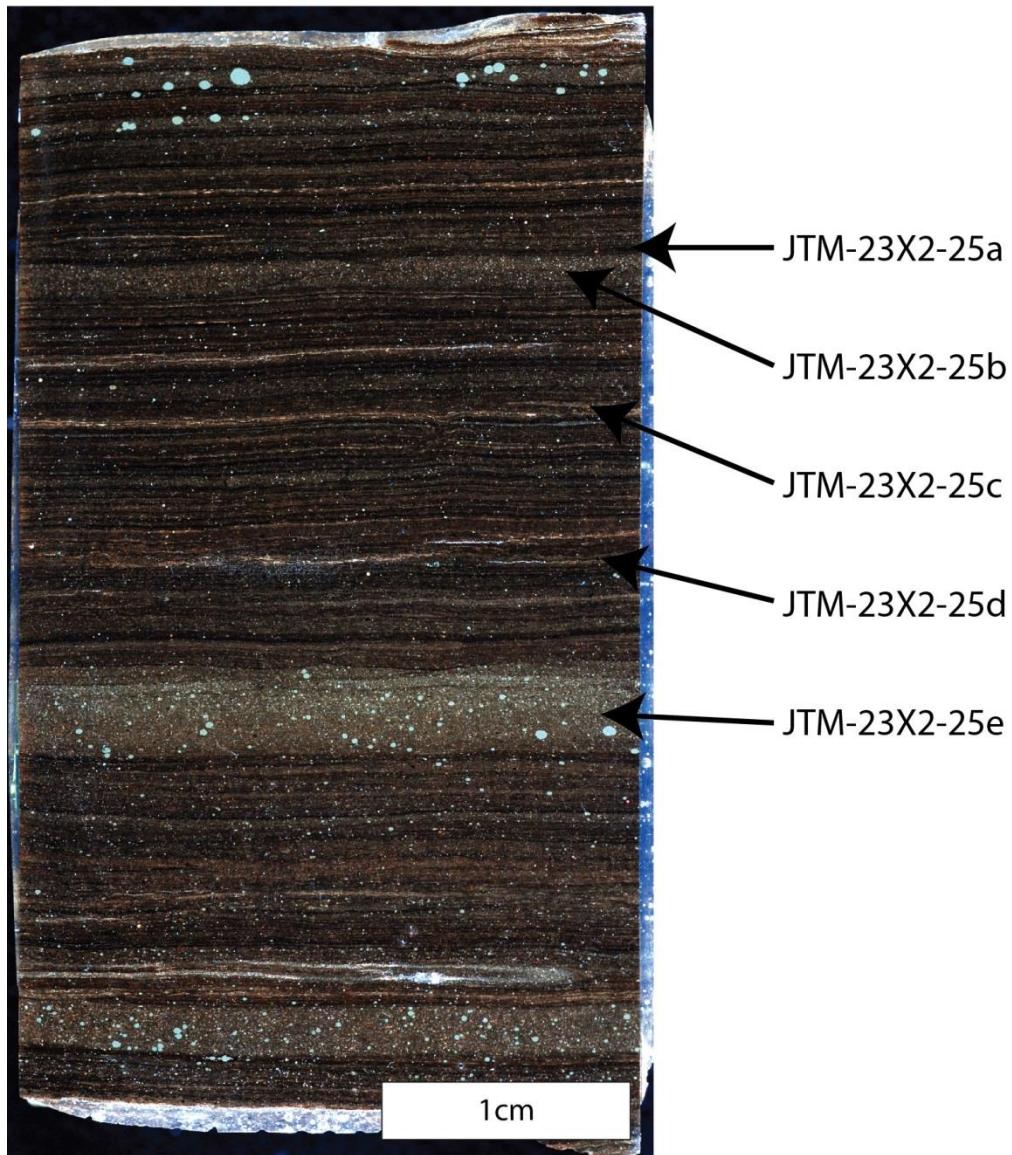


Figure 39. Laminae sample locations and hand sample image of JTM-23X2-25, 632.2m.

Sample Depth: 665.0m

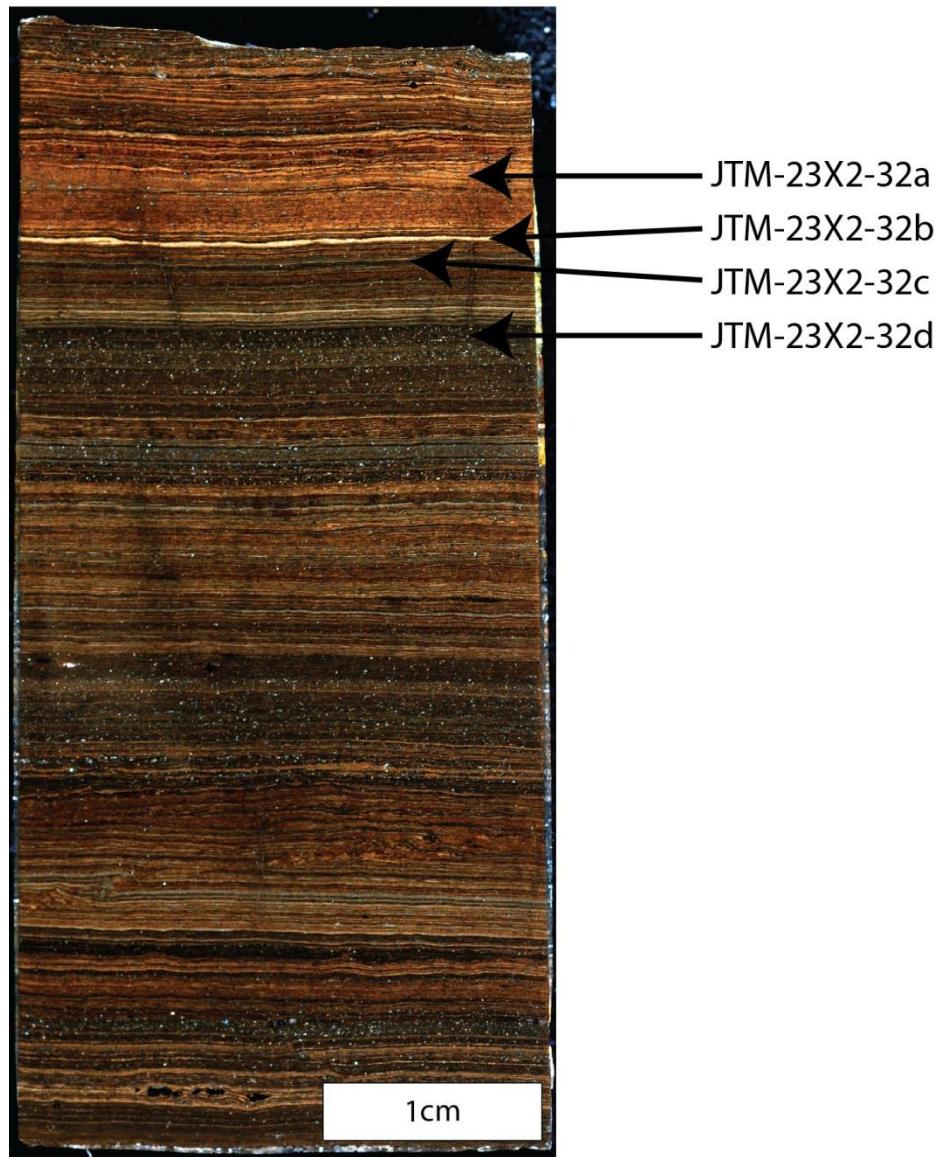


Figure 40. Laminae sample locations and hand sample image of JTM-23X2-32, 665.0m.

Sample Depth: 669.5m

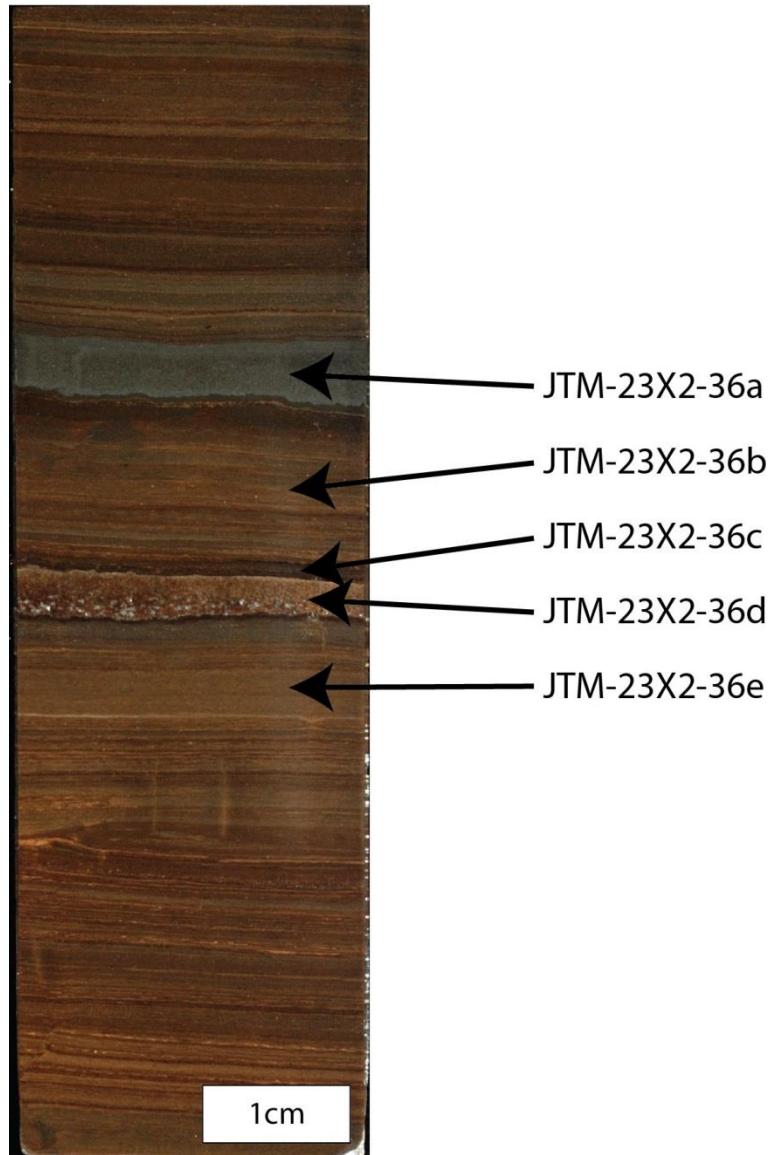


Figure 41. Laminae sample locations and hand sample image of JTM-23X2-36, 669.4m.

Sample Depth: 672.1m



Figure 42. Laminae sample locations and hand sample image of JTM-23X2-37, 672.1m.

Sample Depth: 676.9m

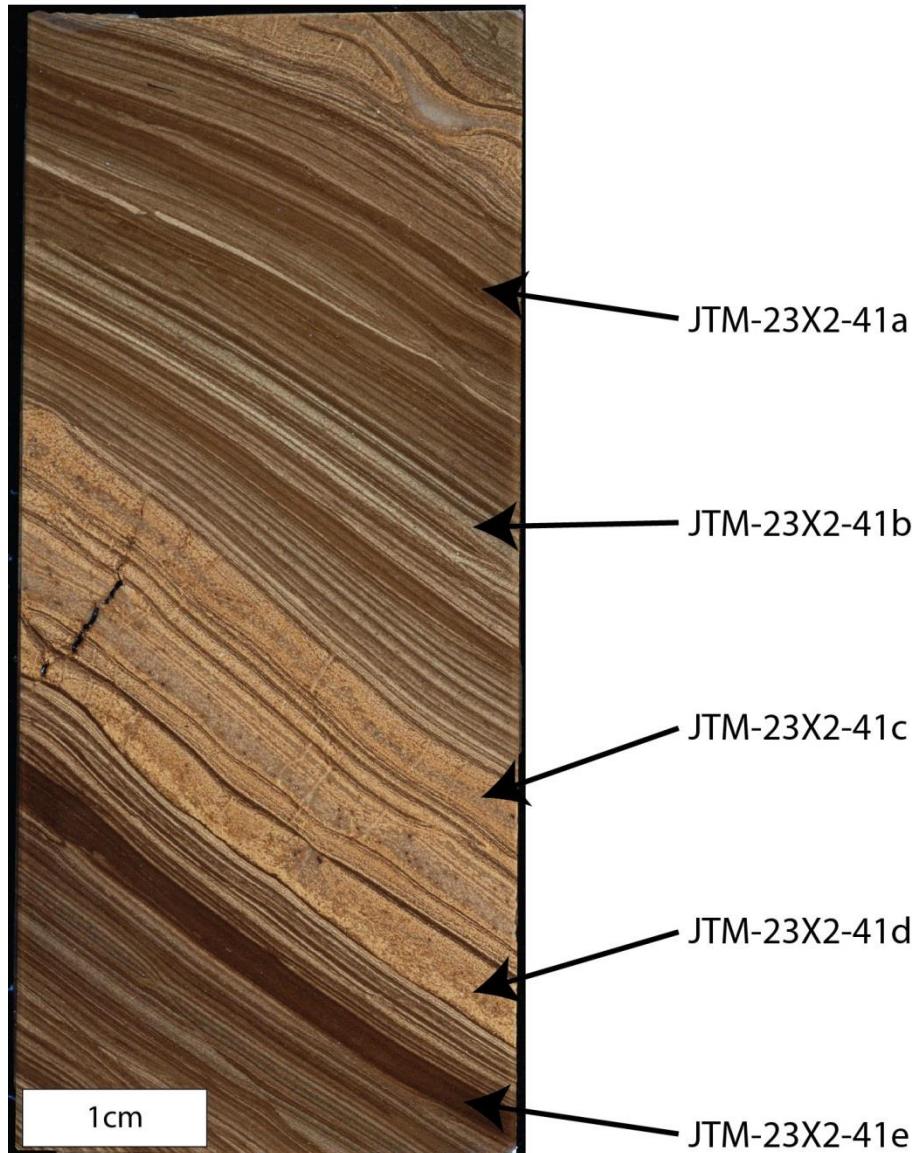


Figure 43. Laminae sample locations and hand sample image of JTM-23X2-41, 676.9m.

## **Appendix C: Stratigraphic Columns**

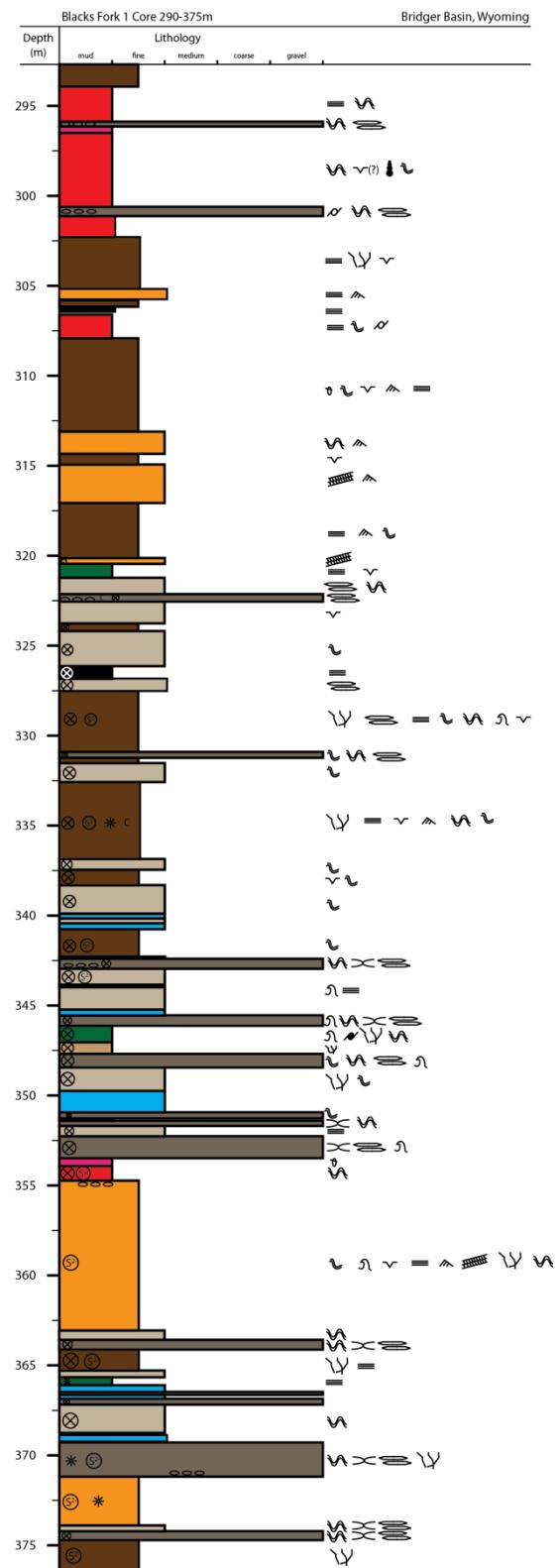


Figure 1. Stratigraphic column of the ERDA 1 Blacks Fork Core from 290-375m. See Figure 3 for the list of symbols and colors used.

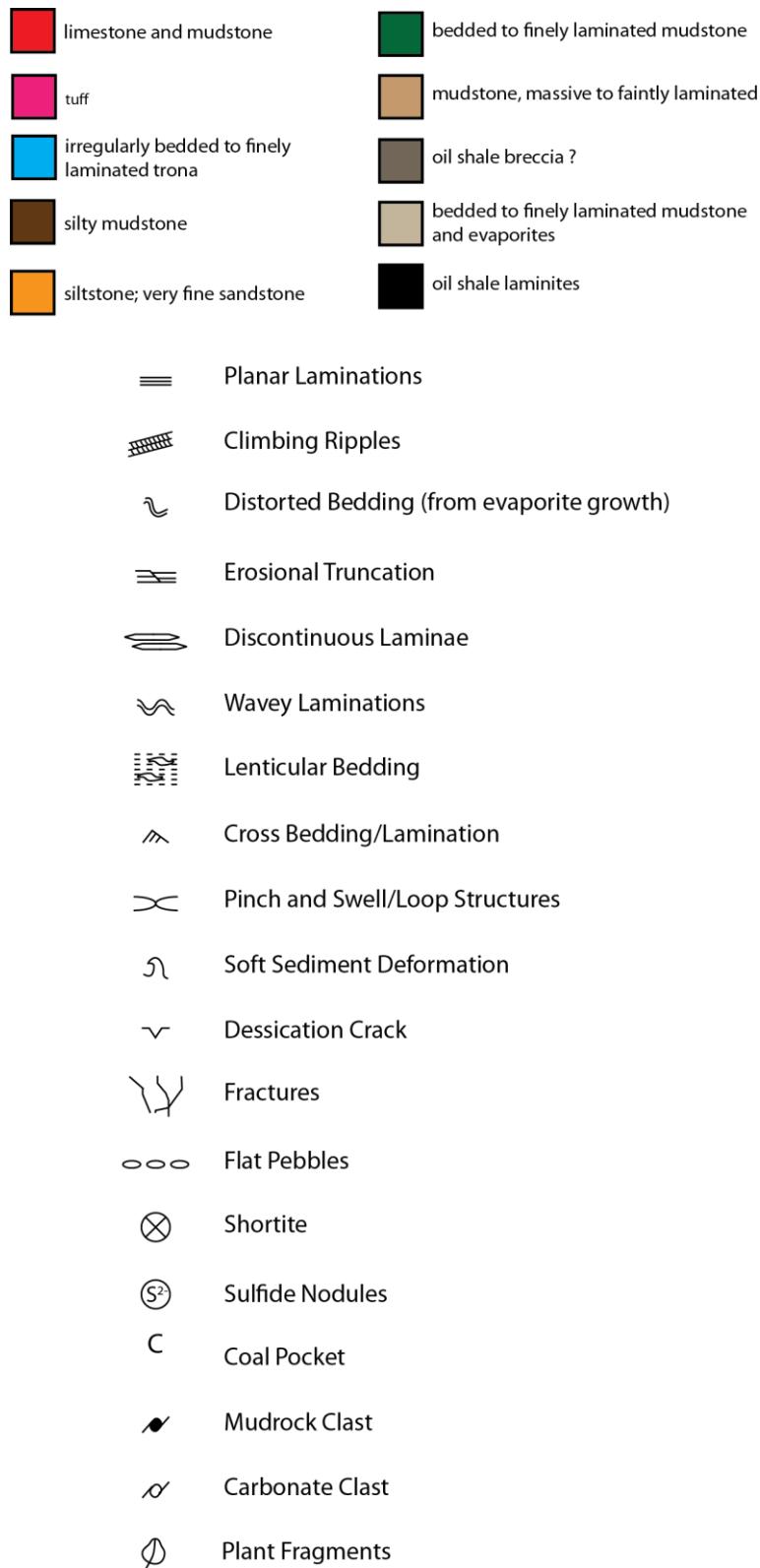


Figure 2. Key for symbols and colors used in the Blacks Fork 1 stratigraphic column.

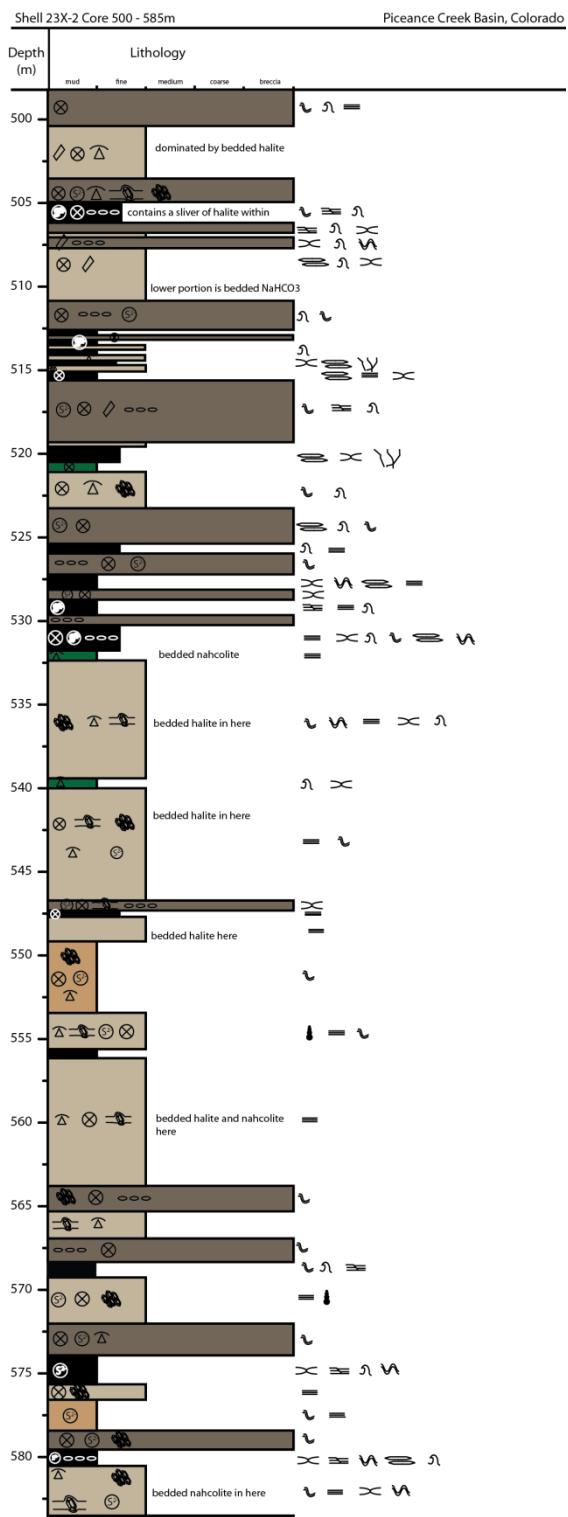


Figure 3. Stratigraphic column of the Shell 23X-2 Core from 500-585m. See Figure 6 for a list of symbols and colors used in the stratigraphic column.

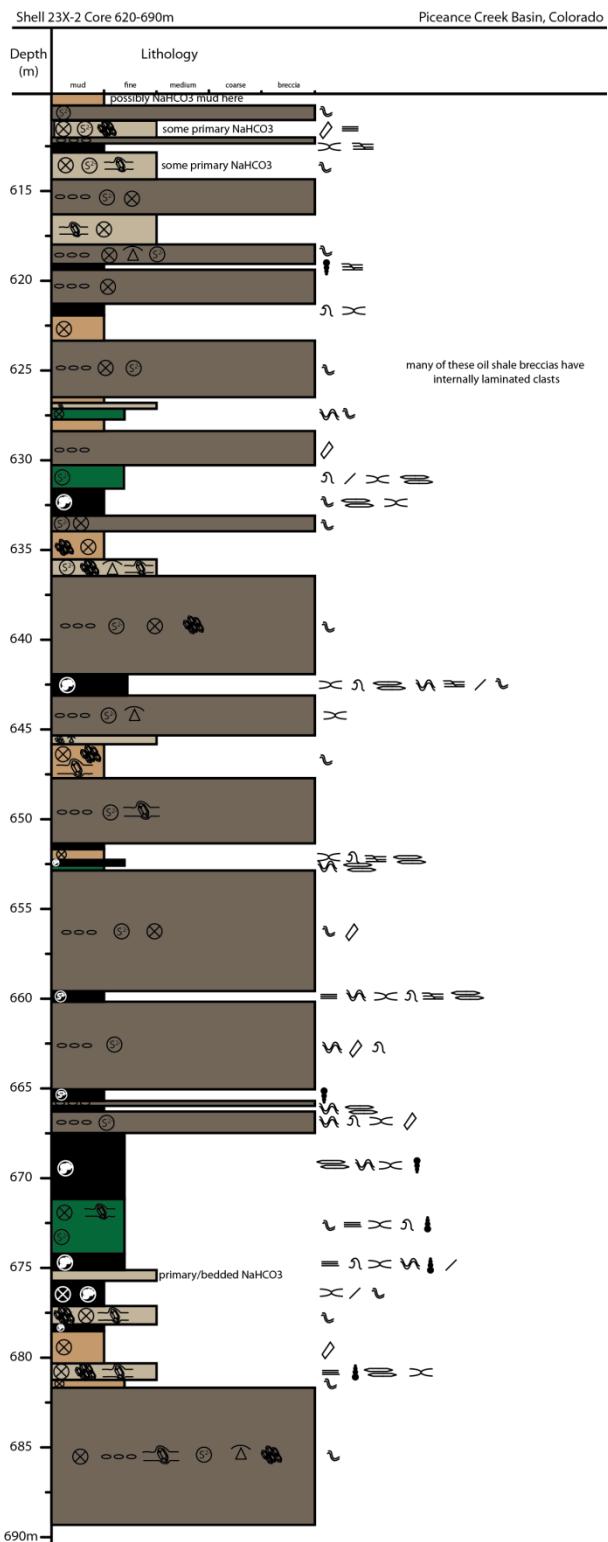


Figure 4. See Figure 6 for a list of symbols and colors used in the stratigraphic column.

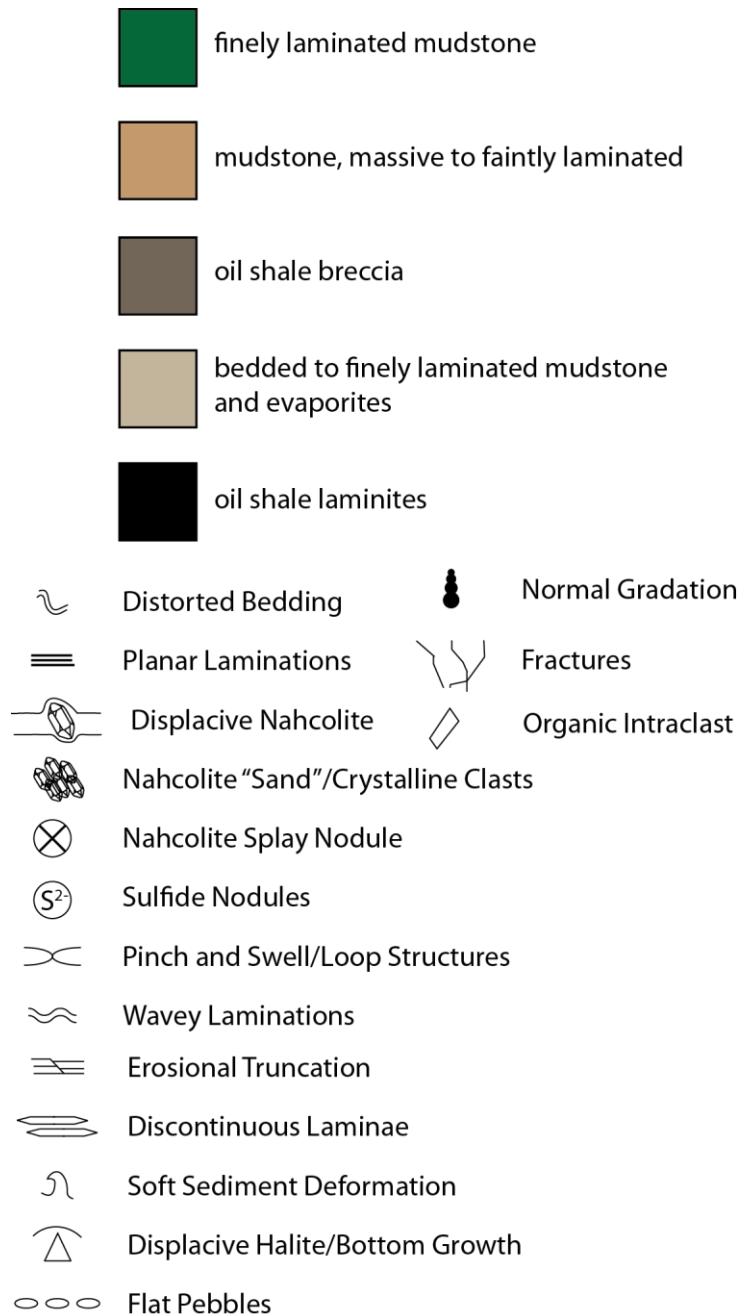


Figure 5. Key for symbols and colors used in the Shell 23X-2 stratigraphic column.

## **Appendix D: Rietveld Refinement Mineralogy**

Part 1: ERDA 1 Blacks Fork Core

Table 3. Mineralogy of select laminae from the ERDA 1 Blacks Fork Core drilled with a micro mill and analyzed with powder X-ray diffraction. Samples were further refined using the program GSAS (Larson and Von Dreele, 2000) and Rietveld refinements.

D3

Sample #	Depth (mm)	Stratigraphic Unit	Reduced Chi <sup>2</sup>	Mineral Composition (%)
JTM-BF-2a	121158	Laney Member	5.322	Dolomite (66.868); Calcite (20.751); Quartz (11.620); Pyrite (0.76137)
JTM-BF-2b	121179	Laney Member	4.025	Aragonite (90.252); Quartz (5.3284); Orthoclase (4.4199)
JTM-BF-2c	121182	Laney Member	3.543	Aragonite (91.913); Analcime (4.6663); Quartz (3.4207)
JTM-BF-2d	121150	Laney Member	1.787	Calcite (100)
JTM-BF-2e	121177	Laney Member	4.264	Aragonite (67.866); Analcime (18.068); Quartz (14.066)
JTM-BF-2f	121176	Laney Member	2.865	Aragonite (73.437); Quartz (20.248); Analcime (6.3150)
JTM-BF-2g	121155	Laney Member	2.559	Aragonite (88.537); Quartz (7.5585); Analcime (3.9042)
JTM-BF-2L1	121164	Laney Member	1.366	Aragonite (100)
JTM-BF-2L2	121165	Laney Member	1.834	Aragonite (98.257); Quartz (1.7426)
JTM-BF-2L3	121175	Laney Member	1.209	Aragonite (100)
JTM-BF-2L4	121178	Laney Member	1.327	Aragonite (91.681); Quartz (8.3193)
JTM-BF-2L5	121181	Laney Member	1.416	Aragonite (91.885); Quartz (8.1153)
JTM-BF-2L6	121183	Laney Member	1.235	Aragonite (92.811); Orthoclase (4.5465) Quartz (2.6422)
JTM-BF-2L7	121184	Laney Member	1.710	Aragonite (100)
JTM-BF-2L8	121177	Laney Member	1.557	Aragonite (97.638); Quartz (2.3618)
JTM-BF-3a	121460	Laney Member	2.544	Sanidine (36.291); Aragonite (26.177); Dolomite (17.927); Quartz (11.866); Calcite (7.7387)
JTM-BF-3b	121474	Laney Member	3.818	Buddingtonite (37.580); Orthoclase (32.785); Quartz (18.790); Dolomite (10.846)
JTM-BF-3c	121475	Laney Member	2.607	Calcite (53.845); Dolomite (16.412); Sanidine (16.025); Quartz (13.718)
JTM-BF-3d	121498	Laney Member	3.482	Albite (76.796); Quartz (20.391); Analcime (2.8134)

JTM-BF-4a	122086	Laney Member	5.487	Sanidine (73.120); Buddingtonite (26.880)
JTM-BF-4b	122096	Laney Member	1.383	Dolomite (81.022); Orthoclase (14.988); Quartz (3.9903)
JTM-BF-4c	122100	Laney Member	5.976	Buddingtonite (45.789); Orthoclase (44.787); Pyrite (4.8891); Quartz (4.5374)
JTM-BF-4d	122074	Laney Member	4.400	Buddingtonite (34.248); Dawsonite (27.472); Albite (20.708); Quartz (7.9377)
JTM-BF-4e	122112	Laney Member	1.874	Dolomite (76.561); Dawsonite (19.179); Quartz (4.2595)
JTM-BF-4f	122107	Laney Member	1.988	Sanidine (53.917); Dolomite (32.808); Quartz (8.1741); Analcime (5.1003)
JTM-BF-4g	122081	Laney Member	2.373	Sanidine (47.949); Buddingtonite (41.322); Dolomite (6.9432); Analcime (2.0561); Quartz (1.7296)
JTM-BF-5a	123304	Laney Member	2.552	Aragonite (77.024); Quartz (12.743); Analcime (10.233)
JTM-BF-5b	123304	Laney Member	2.763	Aragonite (78.632); Quartz (21.368)
JTM-BF-8a	125835	Laney Member	1.562	Calcite (95.630); Quartz (4.3704)
JTM-BF-8b	125838	Laney Member	1.571	Calcite (94.294); Quartz (5.706)
JTM-BF-8c	125841	Laney Member	1.998	Calcite (57.184); Quartz (42.816)
JTM-BF-8d	125891	Laney Member	6.177	Microcline (59.498); Buddingtonite (30.026); Dolomite (10.477)
JTM-BF-8e	125881	Laney Member	1.215	Buddingtonite (59.090); Orthoclase (28.465); Fluorite (12.444)
JTM-BF-8f	125870	Laney Member	1.498	Calcite (85.575); Dolomite (11.997); Quartz (2.4286)
JTM-BF-8g	125832	Laney Member	7.402	Albite (47.774); Dolomite (30.825); Analcime (13.498); Quartz (5.8347); Dawsonite (2.0683)
JTM-BF-8h	125860	Laney Member	1.513	Calcite (87.240); Quartz (12.760)
JTM-BF-8i	125839	Laney Member	1.939	Calcite (95.329); Dolomite (2.9711); Quartz (1.6996)
JTM-BF-8j	125846	Laney Member	1.948	Calcite (88.323); Dolomite (9.4784); Quartz (2.1990)
JTM-BF-8k	125851	Laney Member	2.113	Calcite (97.263); Quartz (2.7373)
JTM-BF-8l	125877	Laney Member	2.269	Calcite (83.783); Dolomite (12.772); Quartz (3.4450)
JTM-BF-9a	126036	Laney Member	1.681	Calcite (76.138); Dolomite (11.763); Analcime 6.6306); Quartz (4.0777); Pyrite (1.3905)
JTM-BF-9b	126049	Laney Member	1.404	Calcite (77.452); Dolomite (12.845); Analcime (5.9592); Quartz

JTM-BF-9c	126053	Laney Member	6.191	(3.7445) Anorthoclase (67.825); Calcite (25.930); Quartz (4.4262); Analcime (1.8193)
JTM-BF-9d	126065	Laney Member	3.394	Dolomite (44.161); Analcime (30.563); Quartz (16.820); Pyrite (8.4563)
JTM-BF-9e	126070	Laney Member	1.481	Calcite (82.451); Dolomite (9.2311); Analcime (6.1364); Quartz (2.1817)
JTM-BF-9f	126076	Laney Member	1.745	Calcite (62.414); Analcime (27.626); Quartz (9.9608)
JTM-BF-10a	126773	Laney Member	1.194	Dolomite (49.560); (Buddingtonite 44.928); Quartz (5.5119)
JTM-BF-10b	126789	Laney Member	2.878	Dolomite (42.879); Sanidine (41.261); Analcime (13.120); Pyrite (2.7405)
JTM-BF-10c	126814	Laney Member	1.743	Dolomite (41.854); Fluorite (34.140); Buddingtonite (20.076); Quartz (3.9306)
JTM-BF-10d	126785	Laney Member	3.402	Sanidine (78.870); Dolomite (18.497); Quartz (2.6330)
JTM-BF-13a	132757	Laney Member	3.810	Albite (68.683); Analcime (23.898); Quartz (7.4190)
JTM-BF-13b	132760	Laney Member	4.089	Analcime (72.809); Quartz (25.056); Calcite (2.1351)
JTM-BF-13c	132766	Laney Member	4.247	Calcite (60.037); Quartz (39.963)
JTM-BF-13d	132768	Laney Member	2.971	Calcite (95.276); Quartz (4.7236)
JTM-BF-13e	132773	Laney Member	3.665	Calcite (71.277); Quartz (21.828); Analcime (6.8955)
JTM-BF-13f	132782	Laney Member	2.533	Anorthoclase (63.486); Analcime (22.709); Quartz (7.6654); Calcite (6.1389)
JTM-BF-13g	132787	Laney Member	3.436	Calcite (49.007); Quartz (18.795); Analcime (17.597); Dolomite (14.602)
JTM-BF-14a	133410	Laney Member	3.089	Calcite (70.208); Dolomite (24.243); Quartz (5.5490)
JTM-BF-14b	133418	Laney Member	3.667	Calcite (72.426); Analcime (21.815); Quartz (5.7594)
JTM-BF-14c	133433	Laney Member	3.930	Calcite (71.607); Analcime (24.277); Quartz (4.1158)
JTM-BF-14d	133443	Laney Member	4.710	Calcite (42.261); Quartz (40.527); Analcime (17.213)
JTM-BF-16a	135313	Laney Member	3.844	Dolomite (42.674); Calcite (33.034); Albite (14.995); Quartz (9.2973)
JTM-BF-16b	135331	Laney Member	3.761	Calcite (35.755); Dolomite (31.446); Albite (19.578); Quartz

				(11.488); Pyrite (1.7328)
JTM-BF-17a	135984	Laney Member	2.528	Calcite (57.832); Dolomite (40.120); Quartz (2.0479)
JTM-BF-17b	136001	Laney Member	2.670	Calcite (57.669); Dolomite (38.851); Quartz (3.4809)
JTM-BF-17c	136014	Laney Member	2.537	Calcite (95.274); Quartz (4.7260)
JTM-BF-18a	137069	Wilkins Peak Member	5.019	Dolomite (72.882); Quartz (24.307); Dawsonite (2.8114)
JTM-BF-18b	137074	Wilkins Peak Member	3.260	Calcite (52.890); Dolomite (36.284); Quartz (10.827)
JTM-BF-18c	137088	Wilkins Peak Member	3.249	Calcite (93.989); Quartz (6.0108)
JTM-BF-18d	137095	Wilkins Peak Member	4.092	Dolomite (86.618); Quartz (11.193); Dawsonite (2.1894)
JTM-BF-19a	138230	Wilkins Peak Member	3.800	Sanidine (60.135); Dolomite (35.711); Quartz (4.1543)
JTM-BF-19b	138236	Wilkins Peak Member	5.901	Dolomite (36.849); Quartz (33.587); Calcite (20.948)
JTM-BF-19c	138241	Wilkins Peak Member	4.965	Dolomite (83.496); Albite (10.333); Quartz (6.1713)
JTM-BF-19d	138228	Wilkins Peak Member	4.008	Dolomite (86.710); Quartz (13.290)
JTM-BF-20a	139890	Wilkins Peak Member	4.435	Dolomite (77.330); Quartz (22.670)
JTM-BF-20b	139895	Wilkins Peak Member	4.723	Calcite (39.070); Dolomite (37.965); Quartz (15.707); Shortite (7.2581)
JTM-BF-20c	139908	Wilkins Peak Member	5.340	Dolomite (67.411); Quartz (25.532); Anorthoclase (7.0565)
JTM-BF-21a	141280	Wilkins Peak Member	3.706	Dolomite (54.792); Sanidine (33.373); Quartz (11.836)
JTM-BF-21b	141282	Wilkins Peak Member	4.135	Calcite (89.469); Quartz (10.531)

JTM-BF-22a	141977	Wilkins Peak Member	2.771	Orthoclase (38.488); Calcite (33.079); Gaylussite (20.458); Quartz (7.9745)
JTM-BF-22b	141991	Wilkins Peak Member	4.696	Shortite (60.217); Calcite (22.903); Gaylussite (16.879)
JTM-BF-22c	141994	Wilkins Peak Member	4.116	Sanidine (59.333); Dolomite (25.604); Quartz (15.063)
JTM-BF-22d	142006	Wilkins Peak Member	3.244	Calcite (46.431); Sanidine (34.995); Dolomite (9.6632); Quartz (7.1742); Pyrite (1.7366)
JTM-BF-23a	144124	Wilkins Peak Member	3.584	Shortite (58.772); Dolomite (34.607); Quartz (6.6218)
JTM-BF-23b	144127	Wilkins Peak Member	3.782	Anorthoclase (71.391); Dolomite (25.291); Quartz (3.3184)
JTM-BF-23c	144135	Wilkins Peak Member	4.316	Sanidine (96.171); Quartz (3.8290)
JTM-BF-24a	146544	Wilkins Peak Member	4.099	Dolomite (53.672); Calcite (19.171); Shortite (17.332); Quartz (9.8245)
JTM-BF-24b	146555	Wilkins Peak Member	3.759	Dolomite (66.797); Calcite (22.420); Quartz (10.782)
JTM-BF-24c	146561	Wilkins Peak Member	3.285	Calcite (50.855); Dolomite (28.269); Quartz (20.876)
JTM-BF-24d	146580	Wilkins Peak Member	3.718	Shortite (60.217); Calcite (22.903); Gaylussite (16.879)
JTM-BF-25a	153707	Wilkins Peak Member	4.062	Shortite (68.987); Dolomite (22.046); Quartz (5.8543); Calcite (3.1131)
JTM-BF-25b	153720	Wilkins Peak Member	13.090	Shortite (36.513); Dolomite (36.281); Calcite (19.549); Quartz (7.6759)
JTM-BF-25c	153627	Wilkins Peak Member	4.261	Dolomite (79.223); Calcite (12.709); Quartz (8.0676)
JTM-BF-26a	154018	Wilkins Peak Member	4.010	Dolomite (75.812); Quartz (24.188)
JTM-BF-26b	154026	Wilkins Peak	3.914	Dolomite (62.034); Albite (20.221); Quartz (17.745)

		Member		
JTM-BF-26c	154029	Wilkins Peak Member	3.288	Shortite (93.770); Pyrite (4.7747); Quartz (1.4557)
JTM-BF-33a	167973	Wilkins Peak Member	4.550	Dolomite (45.093); Calcite (32.099); Quartz (22.809)
JTM-BF-33b	168006	Wilkins Peak Member	2.893	Calcite (54.624); Sanidine (27.378); Dolomite (13.333); Quartz (4.6640)
JTM-BF-33c	168019	Wilkins Peak Member	4.086	Dolomite (51.708); Sanidine (39.631); Quartz (8.6606)
JTM-BF-34a	168208	Wilkins Peak Member	3.081	Dolomite (83.591); Calcite (9.5089); Quartz (6.8999)
JTM-BF-34b	168215	Wilkins Peak Member	4.041	Calcite (82.676); Dolomite (10.779); Quartz (6.5444)
JTM-BF-34c	168257	Wilkins Peak Member	4.737	Calcite (76.238); Dolomite (15.271); Quartz (8.4914)
JTM-BF-34d	168215	Wilkins Peak Member	2.870	Dolomite (75.862); Microcline (19.603); Quartz (4.5351)
JTM-BF-35a	168509	Wilkins Peak Member	2.486	Calcite (64.924); Dolomite (26.708); Quartz (8.3675)
JTM-BF-35b	168510	Wilkins Peak Member	3.039	Dolomite (60.838); Anorthoclase (34.230); Quartz (4.9323)
JTM-BF-35c	168511	Wilkins Peak Member	3.738	Dolomite (92.268); Quartz (7.7321)
JTM-BF-35d	168554	Wilkins Peak Member	3.813	Dolomite (77.190); Microcline (18.080); Quartz (4.7307)
JTM-BF-35e	168555	Wilkins Peak Member	4.185	Sanidine (70.950); Dolomite (25.007); Quartz (4.0432)
JTM-BF-35f	168556	Wilkins Peak Member	4.053	Sanidine (64.395); Buddingtonite (26.474); Quartz (5.8053); Pyrite (3.3265)
JTM-BF-39a	295594	Wilkins Peak Member	2.905	Dolomite (39.261); Calcite (32.178); Anorthoclase (22.374); Quartz (6.1865)

JTM-BF-39b	295611	Wilkins Peak Member	2.607	Calcite (68.972); Dolomite (27.146); Quartz (3.8822)
JTM-BF-39c	295617	Wilkins Peak Member	3.695	Calcite (54.381); Dolomite (40.603); Quartz (5.0162)
JTM-BF-39d	295641	Wilkins Peak Member	3.376	Dolomite (94.574); Quartz (5.4255)
JTM-BF-44a	306869	Wilkins Peak Member	3.558	Calcite (55.287); Albite (17.009); Dolomite (16.845); Quartz (10.860)
JTM-BF-44b	306871	Wilkins Peak Member	3.728	Dolomite (51.442); Albite (45.809); Quartz (2.7489)
JTM-BF-44c	306884	Wilkins Peak Member	3.900	Calcite (57.445); Dolomite (31.838); Quartz (5.6297); Albite (5.0876)
JTM-BF-50a	329488	Wilkins Peak Member	2.692	Dolomite (64.032); Shortite (26.822); Albite (7.5826); Quartz (1.5635)
JTM-BF-50b	329496	Wilkins Peak Member	2.878	Shortite (88.930); Dolomite (10.377); Quartz (0.69262)
JTM-BF-55a	347897	Wilkins Peak Member	3.078	Dolomite (92.679); Albite (6.7284); Quartz (0.5927)
JTM-BF-55b	347900	Wilkins Peak Member	2.733	Dolomite (87.836); Albite (10.071); Quartz (2.0932)
JTM-BF-55c	347901	Wilkins Peak Member	2.496	Dolomite (91.179); Albite (7.4883); Quartz (1.3324)
JTM-BF-55d	347910	Wilkins Peak Member	2.717	Dolomite (94.810); Albite (4.4130); Quartz (0.77715)
JTM-BF-57a	351640	Wilkins Peak Member	2.461	Dolomite (67.442); Anorthoclase (31.840); Quartz (0.71806)
JTM-BF-57b	351648	Wilkins Peak Member	3.113	Dolomite (66.242); Microcline (33.090); Quartz (0.66749)
JTM-BF-57c	351662	Wilkins Peak Member	3.537	Dolomite (50.870); Anorthoclase (37.797); Quartz (11.333)
JTM-BF-57d	351682	Wilkins Peak	2.139	Dolomite (75.157); Microcline (24.261); Quartz (0.58156)

		Member		
JTM-BF-64a	366961	Wilkins Peak Member	2.548	Dolomite (97.899); Quartz (2.1008)
JTM-BF-64b	366962	Wilkins Peak Member	3.176	Dolomite (98.758); Quartz (1.2421)
JTM-BF-64c	366968	Wilkins Peak Member	2.925	Dolomite (75.122); Sanidine (23.925); Quartz (0.95278)

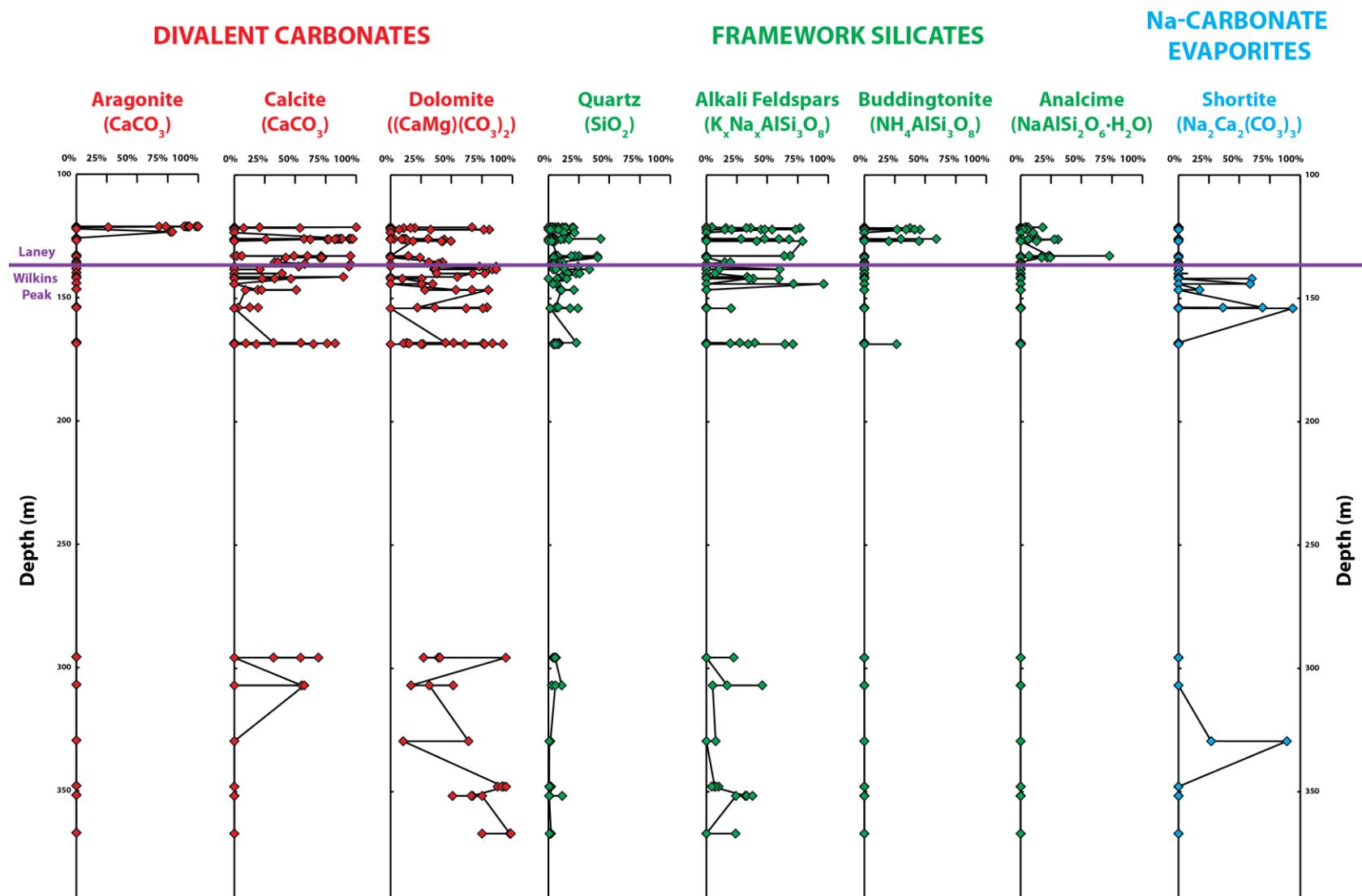


Figure 6. Graphical representation of major minerals and variable abundances through depth identified from select laminae in samples of the ERDA 1 Blacks Fork Core.

Table 4. Tabulated Rietveld refinement values used to determine the Mg-content of calcite from the ERDA 1 Blacks Fork Core. The calculated value is determined for the volume parameter from the equation of Titschack et al. (2011), Figure 1.

Sample #	Depth (m)	a (Å)	a (Å) STD	c (Å)	c (Å) STD	Volume (Å <sup>3</sup> )	Volume (Å <sup>3</sup> ) STD	Reduced Chi <sup>2</sup>	Mg-content (mol %)	Mg-content STD (mol %)
JTM-BF-2a	121.15	4.98	0.00	17.04	0.00	365.69	0.04	5.32	2.58	0.05
JTM-BF-2d	121.15	4.99	0.00	17.04	0.00	367.00	0.14	1.79	1.21	0.14
JTM-BF-3a	121.44	4.98	0.00	16.96	0.01	363.80	0.19	2.54	4.55	0.19
JTM-BF-3c	121.44	4.97	0.00	17.00	0.00	363.48	0.10	2.61	4.89	0.11
JTM-BF-8a	125.83	4.98	0.00	17.04	0.00	366.37	0.05	1.56	1.86	0.05
JTM-BF-8b	125.83	4.98	0.00	17.03	0.00	366.40	0.06	1.57	1.83	0.06
JTM-BF-8c	125.83	4.98	0.00	17.03	0.00	366.57	0.18	2.00	1.66	0.19
JTM-BF-8f	125.83	4.98	0.00	17.04	0.00	366.31	0.04	1.50	1.93	0.04
JTM-BF-8h	125.83	4.98	0.00	17.04	0.00	366.27	0.06	1.51	1.97	0.07
JTM-BF-8i	125.83	4.98	0.00	17.04	0.00	366.42	0.03	1.94	1.81	0.03
JTM-BF-8j	125.83	4.98	0.00	17.04	0.00	366.65	0.03	1.95	1.57	0.03
JTM-BF-8k	125.83	4.98	0.00	17.04	0.00	366.59	0.09	2.11	1.63	0.10
JTM-BF-8l	125.83	4.98	0.00	17.03	0.00	366.29	0.04	2.27	1.95	0.05
JTM-BF-9a	126.03	4.98	0.00	17.03	0.00	366.17	0.06	1.68	2.07	0.06
JTM-BF-9b	126.03	4.98	0.00	17.04	0.00	366.33	0.07	1.40	1.91	0.07
JTM-BF-9c	126.03	4.98	0.00	17.02	0.00	366.09	0.10	6.19	2.16	0.11
JTM-BF-9e	126.03	4.98	0.00	17.04	0.00	366.31	0.05	1.48	1.92	0.05
JTM-BF-9f	126.03	4.98	0.00	17.02	0.01	365.30	0.13	1.75	2.98	0.14
JTM-BF-13b	132.74	4.98	0.01	17.04	0.03	366.02	0.72	4.09	2.23	0.75
JTM-BF-13c	132.74	4.98	0.00	17.05	0.00	366.61	0.04	4.25	1.61	0.05
JTM-BF-13d	132.74	4.98	0.00	17.04	0.00	366.55	0.05	2.97	1.68	0.05

JTM-BF-13e	132.74	4.98	0.00	17.04	0.00	366.57	0.08	3.67	1.65	0.08
JTM-BF-13f	132.74	4.98	0.00	17.08	0.01	366.74	0.28	2.53	1.48	0.29
JTM-BF-13g	132.74	4.98	0.00	17.05	0.00	366.32	0.04	3.44	1.92	0.04
JTM-BF-14a	133.40	4.99	0.00	17.04	0.00	366.93	0.06	3.09	1.28	0.06
JTM-BF-14b	133.40	4.99	0.00	17.04	0.00	366.95	0.07	3.67	1.25	0.07
JTM-BF-14c	133.40	4.99	0.00	17.05	0.00	366.92	0.06	3.93	1.28	0.06
JTM-BF-14d	133.40	4.98	0.00	17.04	0.01	366.69	0.16	4.71	1.53	0.17
JTM-BF-16a	135.31	4.98	0.00	17.04	0.00	366.16	0.10	3.84	2.08	0.10
JTM-BF-16b	135.31	4.98	0.00	17.04	0.00	366.37	0.12	3.76	1.86	0.12
JTM-BF-17a	135.98	4.99	0.00	17.05	0.00	367.34	0.05	2.53	0.85	0.05
JTM-BF-17b	135.98	4.99	0.00	17.05	0.00	366.96	0.05	2.67	1.24	0.05
JTM-BF-17c	135.98	4.99	0.00	17.05	0.00	366.91	0.04	2.54	1.30	0.04
JTM-BF-18b	137.06	4.99	0.00	17.05	0.00	367.42	0.05	3.26	0.77	0.05
JTM-BF-18c	137.06	4.99	0.00	17.05	0.00	367.09	0.03	3.25	1.11	0.03
JTM-BF-19b	138.23	4.99	0.00	17.05	0.01	367.41	0.15	5.90	0.77	0.16
JTM-BF-20b	139.88	4.99	0.00	17.04	0.00	367.35	0.10	4.72	0.84	0.11
JTM-BF-21b	141.26	4.99	0.00	17.05	0.00	366.99	0.04	4.14	1.21	0.05
JTM-BF-22a	141.98	4.99	0.00	17.03	0.00	366.89	0.07	2.77	1.32	0.07
JTM-BF-22b	141.98	4.99	0.00	17.05	0.00	367.10	0.06	4.70	1.10	0.06
JTM-BF-22d	141.98	4.99	0.00	16.14	0.01	367.58	0.06	3.24	0.59	0.06
JTM-BF-24a	146.53	4.98	0.00	17.04	0.01	366.72	0.14	4.10	1.49	0.14
JTM-BF-24b	146.53	4.99	0.00	17.04	0.01	366.87	0.13	3.76	1.34	0.14
JTM-BF-24c	146.53	4.99	0.00	17.04	0.01	366.69	0.13	3.29	1.53	0.14
JTM-BF-24d	146.53	4.98	0.00	17.03	0.01	365.70	0.30	3.72	2.56	0.31
JTM-BF-25a	153.70	4.98	0.00	17.08	0.02	366.57	0.40	4.06	1.65	0.42
JTM-BF-25b	153.70	4.98	0.00	17.06	0.02	365.81	0.40	13.09	2.45	0.42
JTM-BF-25c	153.70	4.99	0.00	17.04	0.01	367.23	0.18	4.26	0.96	0.19
JTM-BF-33a	167.97	4.99	0.00	17.06	0.01	367.38	0.18	4.55	0.81	0.18

JTM-BF-33b	167.97	4.99	0.00	17.05	0.00	367.45	0.05	2.89	0.73	0.06
JTM-BF-34a	168.20	4.98	0.00	17.06	0.01	366.89	0.26	3.08	1.32	0.28
JTM-BF-34b	168.20	4.99	0.00	17.06	0.00	367.45	0.03	4.04	0.73	0.03
JTM-BF-34c	168.20	4.99	0.00	17.05	0.00	367.39	0.05	4.74	0.80	0.06
JTM-BF-35a	168.50	4.98	0.00	17.05	0.00	366.87	0.04	2.49	1.34	0.04
JTM-BF-35d	168.50	4.98	0.00	17.06	0.01	366.61	0.12	3.81	1.62	0.12
JTM-BF-39a	295.58	4.99	0.00	17.05	0.00	367.43	0.07	2.91	0.75	0.08
JTM-BF-39b	295.58	4.99	0.00	17.05	0.00	367.31	0.04	2.61	0.88	0.04
JTM-BF-39c	295.58	4.99	0.00	17.05	0.00	367.50	0.05	3.70	0.68	0.05
JTM-BF-44a	306.83	4.99	0.00	17.05	0.00	367.43	0.06	3.56	0.75	0.06
JTM-BF-44c	306.83	4.99	0.00	17.05	0.00	367.40	0.05	3.90	0.78	0.05

Table 5. Tabulated Rietveld refinement values used to determine the mole fraction of iron in dolomite from laminae of the ERDA 1 Blacks Fork Core. The calculated value is determined for the volume parameter from the equation of Titschack et al. (2011), Figure 1.

Sample #	Depth (m)	a (Å)	a (Å) STD	c (Å)	c (Å) STD	Volume (Å³)	Volume STD (Å³)	Reduced Chi²	*Mole Fraction Fe	STD	**Mole Fraction Fe	STD	***Mole Fraction Fe	STD
JTM-BF-2a	121.15	4.83	1.01E-03	16.18	5.35E-03	326.41	0.11	5.32	0.85	0.03	0.64	0.02	0.75	0.03
JTM-BF-3a	121.44	4.83	6.36E-04	16.15	3.54E-03	325.89	0.08	2.54	0.78	0.02	0.59	0.01	0.69	0.02
JTM-BF-3b	121.44	4.82	9.76E-04	16.15	5.55E-03	324.88	0.12	3.82	0.63	0.03	0.50	0.02	0.57	0.03
JTM-BF-3c	121.44	4.83	2.39E-03	16.17	1.17E-02	326.32	0.23	2.61	0.84	0.07	0.63	0.04	0.74	0.05
JTM-BF-4b	122.07	4.82	8.10E-04	16.08	4.31E-03	322.96	0.09	1.38	0.36	0.02	0.33	0.02	0.35	0.02
JTM-BF-4d	122.07	4.80	1.75E-03	16.10	9.42E-03	321.75	0.18	4.40	0.19	0.05	0.23	0.03	0.21	0.04
JTM-BF-4e	122.07	4.81	6.96E-04	16.09	3.61E-03	322.60	0.10	1.87	0.31	0.03	0.30	0.02	0.31	0.02
JTM-BF-4f	122.07	4.81	9.15E-04	16.11	4.74E-03	322.92	0.09	1.99	0.35	0.03	0.33	0.02	0.34	0.02
JTM-BF-4g	122.07	4.82	8.58E-04	16.15	4.60E-03	324.39	0.10	2.37	0.56	0.03	0.46	0.02	0.51	0.02
JTM-BF-8d	125.83	4.81	1.00E-03	16.05	5.39E-03	321.19	0.11	6.18	0.11	0.03	0.18	0.02	0.14	0.03
JTM-BF-8f	125.83	4.82	1.40E-03	16.11	7.03E-03	324.30	0.14	1.50	0.55	0.04	0.45	0.02	0.50	0.03
JTM-BF-8g	125.83	4.81	3.03E-04	16.04	1.86E-03	321.30	0.04	7.40	0.12	0.01	0.19	0.01	0.16	0.01
JTM-BF-8i	125.83	4.82	7.03E-04	16.17	3.76E-03	324.98	0.08	1.94	0.65	0.02	0.51	0.01	0.58	0.02
JTM-BF-	125.83	4.83	1.88E-03	16.15	9.19E-03	325.62	0.19	1.95	0.74	0.05	0.57	0.03	0.65	0.04

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	8j														
JTM-BF-8l	125.83	4.83	1.82E-03	16.16	8.96E-03	325.93	0.18	2.27	0.78	0.05	0.60	0.03	0.69	0.04	
JTM-BF-9a	126.03	4.82	2.24E-03	16.13	1.16E-02	324.07	0.23	1.68	0.52	0.07	0.43	0.04	0.48	0.05	
JTM-BF-9b	126.03	4.82	2.19E-03	16.16	1.08E-02	324.82	0.22	1.40	0.63	0.06	0.50	0.04	0.56	0.05	
JTM-BF-9d	126.03	4.83	1.50E-03	16.15	8.24E-03	326.02	0.17	3.39	0.80	0.05	0.61	0.03	0.70	0.04	
JTM-BF-9e	126.03	4.83	2.08E-03	16.13	1.03E-02	325.22	0.21	1.48	0.68	0.06	0.53	0.04	0.61	0.05	
JTM-BF-10a	126.77	4.82	1.50E-03	16.09	7.57E-03	323.40	0.15	1.19	0.42	0.04	0.37	0.03	0.40	0.03	
JTM-BF-10b	126.77	4.83	6.57E-04	16.17	3.46E-03	326.31	0.08	2.88	0.84	0.02	0.63	0.01	0.73	0.02	
JTM-BF-10c	126.77	4.82	2.16E-03	16.08	1.12E-02	323.62	0.22	1.74	0.45	0.06	0.39	0.04	0.42	0.05	
JTM-BF-10d	126.77	4.82	3.45E-04	16.15	1.87E-03	324.70	0.04	3.40	0.61	0.01	0.49	0.01	0.55	0.01	
JTM-BF-13g	132.74	4.81	7.40E-04	16.12	3.98E-03	322.56	0.08	3.44	0.30	0.02	0.30	0.01	0.30	0.02	
JTM-BF-14a	133.40	4.82	2.97E-04	16.07	1.89E-03	322.71	0.04	3.09	0.32	0.01	0.31	0.01	0.32	0.01	
JTM-BF-16a	135.31	4.81	6.31E-04	16.10	3.56E-03	323.12	0.07	3.84	0.38	0.02	0.35	0.01	0.37	0.02	
JTM-BF-16b	135.31	4.81	9.42E-04	16.11	5.21E-03	323.11	0.11	3.76	0.38	0.03	0.35	0.02	0.37	0.02	
JTM-BF-17a	135.98	4.81	3.84E-04	16.05	2.23E-03	321.98	0.04	2.53	0.22	0.01	0.25	0.01	0.23	0.01	
JTM-BF-17b	135.98	4.81	4.02E-04	16.06	2.36E-03	321.86	0.05	2.67	0.20	0.01	0.24	0.01	0.22	0.01	
JTM-BF-18a	137.06	4.81	5.72E-04	16.10	3.40E-03	323.10	0.07	5.02	0.38	0.02	0.35	0.01	0.36	0.02	
JTM-BF-18b	137.06	4.81	5.72E-04	16.10	3.26E-03	322.92	0.06	3.26	0.35	0.02	0.33	0.01	0.34	0.01	
JTM-BF-18d	137.06	4.82	4.12E-04	16.09	2.51E-03	323.10	0.05	4.09	0.38	0.01	0.35	0.01	0.36	0.01	

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JTM-BF-19a	138.23	4.81	5.79E-04	16.09	3.40E-03	322.85	0.07	3.80	0.34	0.02	0.33	0.01	0.33	0.02
JTM-BF-19b	138.23	4.80	1.17E-03	16.12	6.76E-03	322.37	0.12	5.90	0.28	0.04	0.28	0.02	0.28	0.03
JTM-BF-19c	138.23	4.81	3.27E-04	16.08	2.04E-03	322.64	0.04	4.97	0.31	0.01	0.31	0.01	0.31	0.01
JTM-BF-19d	138.23	4.81	4.39E-04	16.09	2.72E-03	322.84	0.05	4.01	0.34	0.02	0.32	0.01	0.33	0.01
JTM-BF-20a	139.88	4.81	6.31E-04	16.09	3.67E-03	322.62	0.07	4.44	0.31	0.02	0.31	0.01	0.31	0.02
JTM-BF-20b	139.88	4.81	8.31E-04	16.10	4.80E-03	322.65	0.09	4.72	0.32	0.03	0.31	0.02	0.31	0.02
JTM-BF-20c	139.88	4.81	5.92E-04	16.09	3.40E-03	322.76	0.07	5.34	0.33	0.02	0.32	0.01	0.32	0.02
JTM-BF-21a	141.26	4.81	4.77E-04	16.08	2.78E-03	322.53	0.06	3.71	0.30	0.02	0.30	0.01	0.30	0.01
JTM-BF-22c	141.98	4.81	8.81E-04	16.10	4.89E-03	322.63	0.10	4.12	0.31	0.03	0.31	0.02	0.31	0.02
JTM-BF-22d	141.98	4.81	1.73E-03	16.14	8.96E-03	322.86	0.18	3.24	0.35	0.05	0.33	0.03	0.34	0.04
JTM-BF-23a	144.11	4.81	5.05E-04	16.04	2.72E-03	321.53	0.05	3.58	0.16	0.02	0.21	0.01	0.18	0.01
JTM-BF-23b	144.11	4.81	3.74E-04	16.05	2.17E-03	321.45	0.04	3.78	0.14	0.01	0.20	0.01	0.17	0.01
JTM-BF-24a	146.53	4.81	5.23E-04	16.07	2.93E-03	322.04	0.06	4.10	0.23	0.02	0.25	0.01	0.24	0.01
JTM-BF-24b	146.53	4.81	5.17E-04	16.07	2.87E-03	322.32	0.06	3.76	0.27	0.02	0.28	0.01	0.27	0.01
JTM-BF-24c	146.53	4.81	3.89E-04	16.08	2.31E-03	321.93	0.05	3.29	0.21	0.01	0.24	0.01	0.23	0.01
JTM-BF-24d	146.53	4.81	4.96E-04	16.05	2.99E-03	321.53	0.06	3.72	0.16	0.02	0.21	0.01	0.18	0.01
JTM-BF-25a	153.70	4.81	3.97E-04	16.03	2.38E-03	321.42	0.05	4.06	0.14	0.01	0.20	0.01	0.17	0.01
JTM-BF-25b	153.70	4.81	3.81E-04	16.03	2.35E-03	321.40	0.05	13.09	0.14	0.01	0.20	0.01	0.17	0.01
JTM-BF-	153.70	4.81	3.36E-04	16.06	2.05E-03	322.00	0.04	4.26	0.22	0.01	0.25	0.01	0.24	0.01

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	25c																	
	JTM-BF-26a	JTM-BF-26b	JTM-BF-33a	JTM-BF-33b	JTM-BF-33c	JTM-BF-34a	JTM-BF-34b	JTM-BF-34c	JTM-BF-34d	JTM-BF-35a	JTM-BF-35b	JTM-BF-35c	JTM-BF-35d	JTM-BF-35e	JTM-BF-39a	JTM-BF-39b	JTM-BF-39c	JTM-BF-39d
	154.00	4.81	6.25E-04	16.08	3.58E-03	322.12	0.07	4.01	0.24	0.02	0.26	0.01	0.25	0.02				
	154.00	4.81	6.75E-04	16.11	3.88E-03	322.48	0.07	3.91	0.29	0.02	0.29	0.01	0.29	0.02				
	167.97	4.81	1.03E-03	16.10	5.76E-03	322.09	0.11	4.55	0.24	0.03	0.26	0.02	0.25	0.03				
	167.97	4.81	1.74E-03	16.11	9.14E-03	322.28	0.17	2.89	0.26	0.05	0.27	0.03	0.27	0.04				
	167.97	4.81	2.55E-04	16.06	1.63E-03	321.69	0.03	4.09	0.18	0.01	0.22	0.01	0.20	0.01				
	168.20	4.81	5.35E-04	16.07	3.19E-03	321.87	0.06	3.08	0.20	0.02	0.24	0.01	0.22	0.01				
	168.20	4.81	1.19E-03	16.10	6.29E-03	322.08	0.12	4.04	0.23	0.03	0.26	0.02	0.25	0.03				
	168.20	4.81	3.46E-04	16.05	2.29E-03	322.16	0.05	4.74	0.24	0.01	0.26	0.01	0.25	0.01				
	168.20	4.81	4.66E-04	16.06	2.75E-03	321.93	0.05	2.87	0.21	0.02	0.24	0.01	0.23	0.01				
	168.50	4.81	4.85E-04	16.06	2.68E-03	321.65	0.06	2.49	0.17	0.02	0.22	0.01	0.20	0.01				
	168.50	4.81	5.81E-04	16.08	3.33E-03	322.21	0.07	3.04	0.25	0.02	0.27	0.01	0.26	0.02				
	168.50	4.81	3.90E-04	16.06	2.30E-03	322.05	0.05	3.74	0.23	0.01	0.25	0.01	0.24	0.01				
	168.50	4.81	2.18E-04	16.05	1.34E-03	321.84	0.03	3.81	0.20	0.01	0.24	0.00	0.22	0.01				
	168.50	4.81	2.55E-04	16.06	1.63E-03	321.99	0.03	4.19	0.22	0.01	0.25	0.01	0.24	0.01				
	295.58	4.81	5.57E-04	16.08	3.17E-03	322.12	0.06	2.91	0.24	0.02	0.26	0.01	0.25	0.01				
	295.58	4.81	6.56E-04	16.09	3.63E-03	322.72	0.07	2.61	0.33	0.02	0.31	0.01	0.32	0.02				
	295.58	4.81	4.82E-04	16.09	2.88E-03	322.85	0.06	3.70	0.34	0.02	0.32	0.01	0.33	0.01				
	295.58	4.81	4.06E-04	16.08	2.33E-03	322.48	0.06	3.38	0.29	0.02	0.29	0.01	0.29	0.01				

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JTM-BF-44a	306.83	4.81	1.36E-03	16.14	7.38E-03	323.50	0.14	3.56	0.44	0.04	0.38	0.02	0.41	0.03
JTM-BF-44b	306.83	4.82	5.43E-04	16.09	3.00E-03	323.07	0.06	3.73	0.38	0.02	0.34	0.01	0.36	0.01
JTM-BF-44c	306.83	4.81	8.56E-04	16.10	4.90E-03	322.71	0.10	3.90	0.32	0.03	0.31	0.02	0.32	0.02
JTM-BF-50a	329.45	4.81	3.71E-04	16.04	2.08E-03	321.27	0.04	2.69	0.12	0.01	0.18	0.01	0.15	0.01
JTM-BF-50b	329.45	4.81	3.60E-04	16.02	2.02E-03	320.64	0.04	2.88	0.03	0.01	0.13	0.01	0.08	0.01
JTM-BF-55a	347.89	4.81	1.74E-04	16.02	1.02E-03	320.77	0.02	3.08	0.05	0.01	0.14	0.00	0.09	0.00
JTM-BF-55b	347.89	4.81	2.86E-04	16.02	1.63E-03	320.67	0.03	2.73	0.03	0.01	0.13	0.01	0.08	0.01
JTM-BF-55c	347.89	4.81	2.27E-04	16.02	1.36E-03	320.71	0.03	2.50	0.04	0.01	0.14	0.00	0.09	0.01
JTM-BF-55d	347.89	4.81	2.05E-04	16.02	1.21E-03	320.84	0.02	2.72	0.06	0.01	0.15	0.00	0.10	0.01
JTM-BF-57a	351.64	4.81	3.09E-04	16.05	1.83E-03	321.67	0.04	2.46	0.18	0.01	0.22	0.01	0.20	0.01
JTM-BF-57b	351.64	4.81	1.84E-04	16.03	1.19E-03	321.67	0.02	3.11	0.18	0.01	0.22	0.00	0.20	0.01
JTM-BF-57c	351.64	4.81	7.00E-04	16.03	3.93E-03	321.40	0.08	3.54	0.14	0.02	0.20	0.01	0.17	0.02
JTM-BF-57d	351.64	4.81	3.00E-04	16.04	1.73E-03	321.52	0.03	2.14	0.15	0.01	0.21	0.01	0.18	0.01
JTM-BF-64a	366.95	4.81	3.19E-04	16.05	1.79E-03	322.07	0.04	2.55	0.23	0.01	0.26	0.01	0.24	0.01
JTM-BF-64b	366.95	4.81	2.46E-04	16.03	1.49E-03	320.85	0.03	3.18	0.06	0.01	0.15	0.01	0.10	0.01
JTM-BF-64c	366.95	4.81	2.39E-04	16.03	1.46E-03	321.16	0.03	2.93	0.10	0.01	0.18	0.01	0.14	0.01

Note: All mole fraction values are reported relative to x, (Fe/Ca(Fe<sub>x</sub>Mg<sub>1-x</sub>)(CO<sub>3</sub>)<sub>2</sub>)

\*Calculation based on Chai and Navrotsky (1996), volume equation

\*\*Calculation based on Reeder and Dollase (1989), volume equation

\*\*\*Calculation is the average of Chai and Navrotsky (1996) and Reeder and Dollase (1989)

## Part 2: Shell 23X-2 Core

Table 6. Mineralogy of select laminae from the Shell 23X-2 Core drilled with a micro mill and analyzed with powder X-ray diffraction. Samples were further refined using the program GSAS (Larson and Von Dreele, 2000) and Rietveld refinements.

<b>Sample #</b>	<b>Depth (mm)</b>	<b>Stratigraphic Unit</b>	<b>Reduced Chi<sup>2</sup></b>	<b>Mineral Composition (%)</b>
JTM-23X2-1a	500648	Parachute Creek Member	3.669	Siderite (53.593); Albite (43.828); Quartz (2.5791)
JTM-23X2-1b	500652	Parachute Creek Member	1.704	Albite (72.872); Dolomite (24.463); Quartz (2.6643)
JTM-23X2-1c	500654	Parachute Creek Member	2.313	Dolomite (82.374); Albite (16.651); Quartz (0.97566)
JTM-23X2-1d	500669	Parachute Creek Member	2.745	Dolomite (84.889); Siderite (13.561); Quartz (1.5493)
JTM-23X2-1e	500694	Parachute Creek Member	2.378	Albite (50.531); Dolomite (39.704); Dawsonite (8.2890); Quartz (1.4759)
JTM-23X2-2a	505969	Parachute Creek Member	2.825	Dolomite (62.522); Albite (26.944); Quartz (10.534)
JTM-23X2-2b	505987	Parachute Creek Member	2.976	Dolomite (62.364); Albite (29.134); Quartz (8.5026)
JTM-23X2-2c	505997	Parachute Creek Member	2.574	Dolomite (50.112); Albite (34.190); Dawsonite (9.2723); Quartz (6.4258)
JTM-23X2-2d	505999	Parachute Creek Member	3.366	Albite (35.564); Dolomite (34.715); Dawsonite (26.905); Quartz (2.8162)
JTM-23X2-4a	520305	Parachute Creek Member	2.323	Dolomite (59.294); Albite (28.978); Dawsonite (7.1084); Quartz (4.6189)
JTM-23X2-4b	520313	Parachute Creek Member	2.875	Dolomite (51.647); Albite (28.939); Dawsonite (12.865); Quartz (6.5482)
JTM-23X2-4c	520315	Parachute Creek Member	2.282	Dolomite (56.735); Albite (24.787); Quartz (10.431); Dawsonite (8.0475)
JTM-23X2-4d	520325	Parachute Creek Member	1.632	Albite (43.398); Dolomite (36.326); Dawsonite (15.223); Quartz (5.0534)

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JTM-23X2-4e	520329	Parachute Creek Member	2.955	Albite (64.315); Dolomite (21.470); Dawsonite (10.615); Quartz (3.5994)
JTM-23X2-4f	520335	Parachute Creek Member	2.556	Dolomite (47.261); Albite (38.228); Dawsonite (8.6226); Quartz (5.8880)
JTM-23X2-6a	528898	Parachute Creek Member	3.217	Albite (82.051); Quartz (17.949)
JTM-23X2-6b	528907	Parachute Creek Member	3.155	Albite (83.799); Quartz (16.201)
JTM-23X2-6c	528944	Parachute Creek Member	3.584	Albite (66.349); Dawsonite (13.167); Quartz (20.484)
JTM-23X2-8a	531421	Parachute Creek Member	2.554	Dolomite (34.292); Dawsonite (27.416); Orthoclase (24.495); Quartz (13.797)
JTM-23X2-8b	531427	Parachute Creek Member	4.305	Orthoclase (68.545); Dawsonite (20.022); Quartz (11.433)
JTM-23X2-8c	531436	Parachute Creek Member	2.489	Orthoclase (42.529); Dawsonite (27.465); Siderite (18.874); Quartz (11.132)
JTM-23X2-8d	531438	Parachute Creek Member	2.668	Siderite (97.779); Quartz (2.2210)
JTM-23X2-8e	531453	Parachute Creek Member	5.120	Dawsonite (43.410); Microcline (35.084); Dolomite (13.110); Quartz (8.3949)
JTM-23X2-8f	531470	Parachute Creek Member	3.847	Buddingtonite (61.879); Orthoclase (30.938); Quartz (7.1831)
JTM-23X2-10a	568902	Parachute Creek Member	2.565	Sanidine (42.901); Dawsonite (22.926); Pyrite (17.809); Quartz (11.576); Dolomite (4.7882)
JTM-23X2-10b	568903	Parachute Creek Member	3.080	Sanidine (36.878); Dawsonite (24.516); Dolomite (23.460); Quartz (15.147)
JTM-23X2-10c	568908	Parachute Creek Member	2.581	Dolomite (30.425); Sanidine (29.612); Dawsonite (18.752); Siderite (11.790); Quartz (9.4208)
JTM-23X2-10d	568910	Parachute Creek Member	3.592	Sanidine (40.734); Dawsonite (24.905); Dolomite (18.435); Quartz (15.926)
JTM-23X2-10e	568924	Parachute Creek Member	2.665	Buddingtonite (49.489); Dawsonite (17.966); Quartz (13.530); Dolomite (11.446); Siderite (7.5693)
JTM-23X2-10f	568930	Parachute Creek Member	2.660	Dolomite (61.154); Siderite (20.232); Sanidine (11.987); Dawsonite (6.6270)

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JTM-23X2-12a	579890	Parachute Creek Member	3.782	Sanidine (39.603); Dawsonite (28.778); Dolomite (15.471); Quartz (11.433)
JTM-23X2-12b	579892	Parachute Creek Member	3.673	Sanidine (30.076); Dawsonite (26.059); Dolomite (22.959); Quartz (20.906)
JTM-23X2-12c	579896	Parachute Creek Member	2.525	Sanidine (33.979); Dolomite (28.096); Marcasite (17.369); Quartz (11.505); Dawsonite (9.0507)
JTM-23X2-12d	578901	Parachute Creek Member	3.921	Sanidine (38.881); Dawsonite (33.598); Dolomite (17.042); Quartz (10.479)
JTM-23X2-16a	612580	Parachute Creek Member	3.536	Dolomite (51.950); Dawsonite (26.086); Quartz (21.963)
JTM-23X2-16b	612588	Parachute Creek Member	4.877	Dawsonite (53.170); Sanidine (22.914); Quartz (14.021); Dolomite (9.8952)
JTM-23X2-16c	612593	Parachute Creek Member	4.242	Dolomite (40.607); Dawsonite (24.743); Sanidine (21.315); Quartz (13.336)
JTM-23X2-16d	612597	Parachute Creek Member	6.102	Dawsonite (28.390); Dolomite (27.584); Quartz (22.415); Sanidine (21.611)
JTM-23X2-16e	612602	Parachute Creek Member	4.439	Dolomite (33.035); Dawsonite (25.924); Quartz (22.144); Sanidine (18.897)
JTM-23X2-16f	612603	Parachute Creek Member	5.085	Dawsonite (39.097); Dolomite (22.374); Sanidine (20.573); Quartz (17.956)
JTM-23X2-23a	631180	Parachute Creek Member	3.157	Sanidine (37.951); Dawsonite (33.459); Quartz (28.590)
JTM-23X2-23b	631181	Parachute Creek Member	3.262	Dawsonite (72.439); Dolomite (15.996); Quartz (11.565)
JTM-23X2-23c	631191	Parachute Creek Member	3.922	Dawsonite (48.155); Dolomite (28.964); Quartz (22.881)
JTM-23X2-23d	631208	Parachute Creek Member	1.917	Dolomite (100)
JTM-23X2-25a	632212	Parachute Creek Member	2.339	Buddingtonite (60.403); Quartz (18.562); Dolomite (12.551); Dawsonite (8.4839)
JTM-23X2-25b	632213	Parachute Creek Member	2.142	Buddingtonite (50.040); Quartz (20.668); Dawsonite (13.503); Dolomite (10.389); Pyrite (5.3994)
JTM-23X2-25c	632218	Parachute Creek Member	1.640	Buddingtonite (64.076); Dolomite (19.597); Quartz (11.907); Dawsonite (4.4201)

D24

JTM-23X2-25d	632224	Parachute Creek Member	2.245	Buddingtonite (56.730); Calcite (13.638); Quartz (12.006); Dolomite (10.632); Dawsonite (6.9953)
JTM-23X2-25e	632228	Parachute Creek Member	2.534	Sanidine (46.831); Dawsonite (17.782); Dolomite (13.287); Quartz (12.478); Pyrite (9.6220)
JTM-23X2-32a	665029	Parachute Creek Member	4.659	Quartz (54.627); Dawsonite (26.776); Dolomite (18.597)
JTM-23X2-32b	665032	Parachute Creek Member	4.164	Dolomite (48.352); Quartz (40.714); Pyrite (10.935)
JTM-23X2-32c	665033	Parachute Creek Member	3.264	Sanidine (74.785); Quartz (18.951); Pyrite (6.2640)
JTM-23X2-32d	665037	Parachute Creek Member	4.225	Sanidine (38.669); Quartz (34.371); Dawsonite (15.803); Pyrite (11.157)
JTM-23X2-36a	669467	Parachute Creek Member	4.283	Pyrite (47.431); Dawsonite (21.469); Buddingtonite (18.968); Magnesite (12.131)
JTM-23X2-36b	669474	Parachute Creek Member	2.773	Sanidine (49.435); Dawsonite (18.489); Quartz (18.438); Dolomite (13.638)
JTM-23X2-36c	669479	Parachute Creek Member	2.485	Buddingtonite (58.874); Dawsonite (15.248); Quartz (14.053); Pyrite (11.824)
JTM-23X2-36d	669480	Parachute Creek Member	2.892	Dawsonite (69.779); Buddingtonite (30.221)
JTM-23X2-36e	669488	Parachute Creek Member	2.567	Orthoclase (39.268); Dolomite (24.768); Quartz (23.769); Dawsonite (12.195)
JTM-23X2-37a	672068	Parachute Creek Member	4.555	Dolomite (47.951); Sanidine (25.831); Quartz (17.210); Magnesite (9.0088)
JTM-23X2-37b	672072	Parachute Creek Member	3.555	Sanidine (52.495); Dolomite (20.189); Dawsonite (16.218); Quartz (11.098)
JTM-23X2-37c	672074	Parachute Creek Member	4.100	Dolomite (58.040); Sanidine (27.052); Quartz (11.019); Dawsonite (3.8889)
JTM-23X2-37d	672083	Parachute Creek Member	4.040	Dolomite (45.190); Sanidine (31.486); Quartz (18.020); Dawsonite (5.3041)
JTM-23X2-37e	672089	Parachute Creek Member	2.943	Dolomite (33.926); Sanidine (33.213); Quartz (24.076); Dawsonite (8.7845)
JTM-23X2-37f	672101	Parachute Creek Member	3.917	Dawsonite (37.126); Sanidine (34.265); Dolomite (18.975); Quartz (9.6342)

JTM-23X2-37g	672109	Parachute Creek Member	3.449	Sanidine (55.644); Dawsonite (32.013); Quartz (7.0566); Dolomite (5.2859)
JTM-23X2-41a	676864	Parachute Creek Member	4.330	Sanidine (35.180); Dawsonite (29.650); Dolomite (23.218); Quartz (11.951)
JTM-23X2-41b	676873	Parachute Creek Member	4.927	Sanidine (33.683); Dawsonite (33.235); Dolomite (18.839); Quartz (14.243)
JTM-23X2-41c	676889	Parachute Creek Member	2.418	Dolomite (98.928); Quartz (1.0720)
JTM-23X2-41d	676895	Parachute Creek Member	2.375	Dolomite (87.618); Quartz (10.346); Dawsonite (2.0361)
JTM-23X2-41e	676902	Parachute Creek Member	3.636	Sanidine (35.687); Dolomite (27.048); Dawsonite (20.894); Quartz (9.9087); Calcite (6.4622)

D26

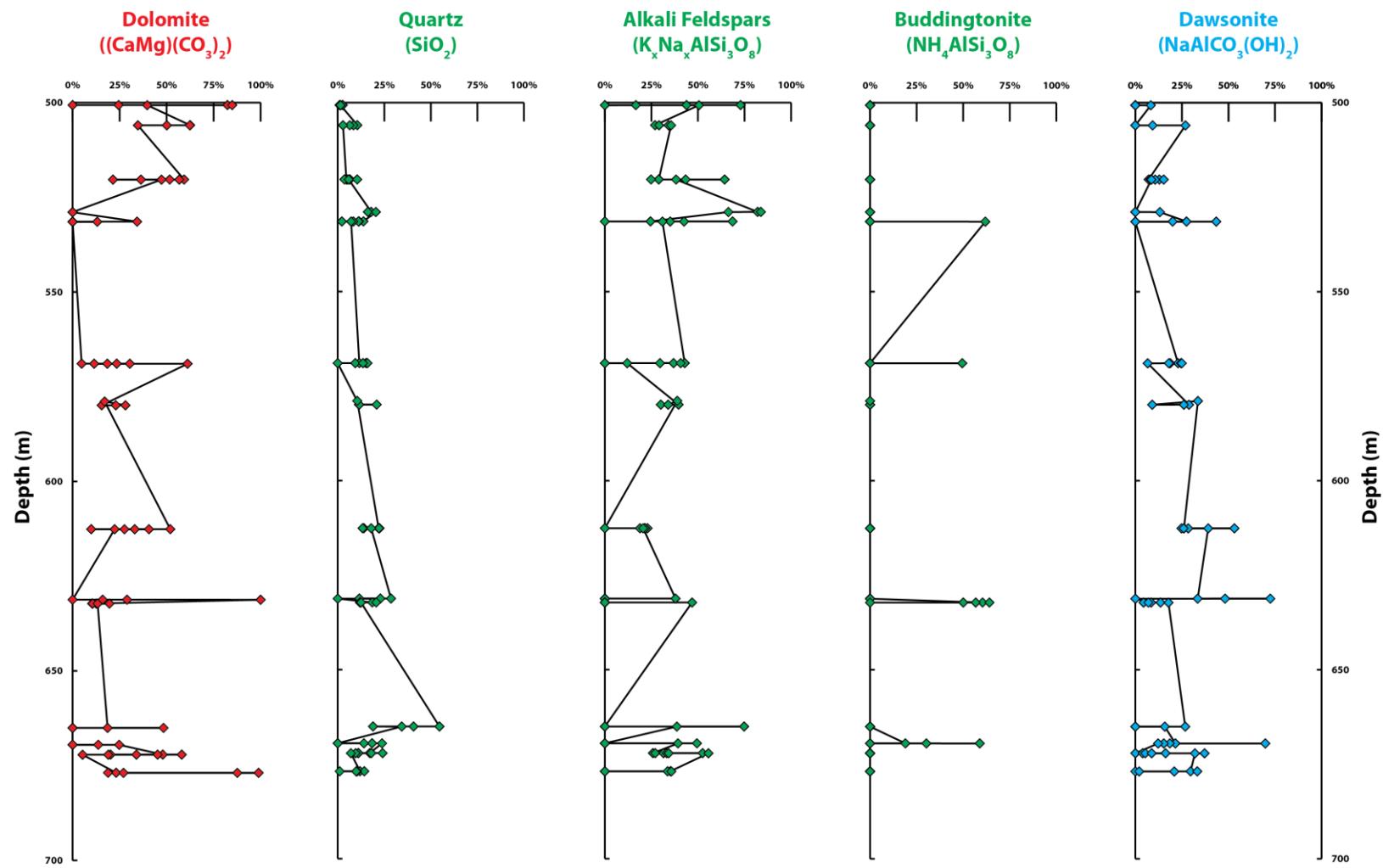


Figure 7. Graphical representation of major minerals and variable abundances through depth identified from select laminae in samples of the Shell 23X-2 Core.

Table 7. Tabulated Rietveld refinement values used to determine the Mg-content of calcite from the Shell 23X-2 Core. The calculated value is determined for the volume parameter from the equation of Titschack et al. (2011), Figure 1.

Sample #	a (Å)	a (Å) STD	c (Å)	c (Å) STD	Volume (Å <sup>3</sup> )	Volume (Å <sup>3</sup> ) STD	Reduced Chi <sup>2</sup>	Mg-content (mol %)	Mg-content STD (mol %)
JTM-23X2- 25d	4.972888	0.001017	17.039011	0.005133	364.916	0.114	2.245	3.386	0.119
JTM-23X2- 41e	4.983131	0.000870	17.022018	0.004145	366.055	0.099	3.636	2.193	0.104

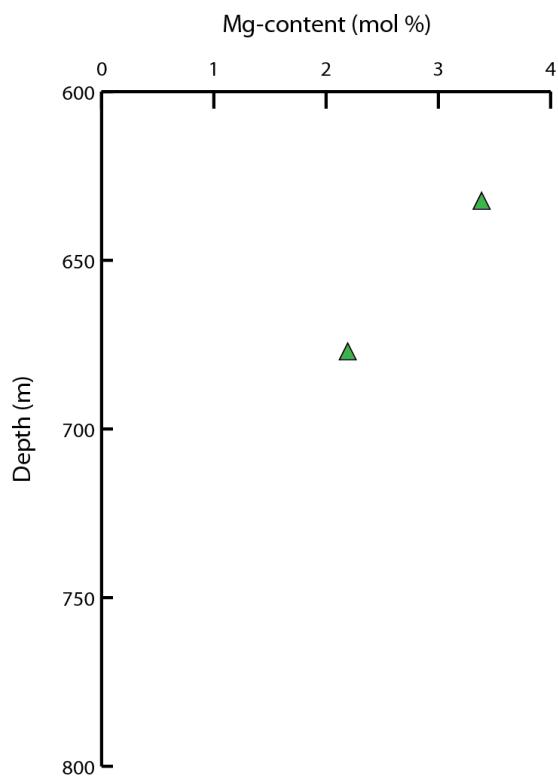


Figure 8. Calculated magnesium concentration of calcite deposits from the Shell 23X-2 Core determined through Rietveld analysis of x-ray powder diffraction results. The equation used to calculate each value was derived from Titschack et al. (2011).

Table 8. Tabulated Rietveld refinement values used to determine the mole fraction of iron in dolomite from laminae of the Blacks Fork 1 Core. The calculated value is determined for the volume parameter from the equation of Titschack et al. (2011), Figure 1.

D29

Sample #	Depth (m)	a (Å)	a (Å) STD	c (Å)	c (Å) STD	Volume (Å³)	Volume STD (Å³)	Reduced Chi²	*Mole Fraction	STD	**Mole Fraction	STD	***Mole Fraction	STD
JTM-23X2-1b	500.6	4.8066	6.48E-04	16.1359	0.003352	322.853	0.071	1.704	0.344	0.020	0.325	0.013	0.335	0.016
JTM-23X2-1c	500.6	4.8059	4.60E-04	16.0257	0.002706	320.546	0.053	2.313	0.015	0.015	0.121	0.009	0.068	0.012
JTM-23X2-1d	500.6	4.8029	3.77E-04	16.0122	0.002257	319.887	0.045	2.745	-0.079	0.013	0.063	0.008	0.000	0.010
JTM-23X2-1e	500.6	4.8167	9.71E-04	16.1013	0.005181	323.510	0.104	2.378	0.438	0.030	0.384	0.018	0.411	0.024
JTM-23X2-2a	506.0	4.8131	4.92E-04	16.1239	0.002508	323.476	0.052	2.825	0.433	0.015	0.381	0.009	0.407	0.012
JTM-23X2-2b	506.0	4.8147	4.73E-04	16.1177	0.002419	323.575	0.050	2.976	0.447	0.014	0.389	0.009	0.418	0.012
JTM-23X2-2c	506.0	4.8137	6.07E-04	16.1143	0.003070	323.365	0.066	2.574	0.417	0.019	0.371	0.012	0.394	0.015
JTM-23X2-2d	506.0	4.8120	7.71E-04	16.1217	0.004189	323.292	0.130	3.366	0.407	0.037	0.364	0.023	0.386	0.030
JTM-23X2-4a	520.3	4.8099	4.41E-04	16.0478	0.002460	321.533	0.048	2.323	0.156	0.014	0.208	0.009	0.182	0.011

D30	JTM-23X2-4b	520.3	4.8105	2.52E-04	16.0384	0.001567	321.421	0.031	2.875	0.140	0.009	0.199	0.005	0.169	0.007
	JTM-23X2-4c	520.3	4.8104	6.39E-04	16.0454	0.003491	321.549	0.068	2.282	0.158	0.019	0.210	0.012	0.184	0.016
	JTM-23X2-4d	520.3	4.8107	5.02E-04	16.0233	0.003000	321.148	0.058	1.632	0.101	0.017	0.174	0.010	0.138	0.013
	JTM-23X2-4e	520.3	4.8071	1.85E-03	16.1343	0.009126	322.886	0.180	2.955	0.349	0.051	0.328	0.032	0.339	0.042
	JTM-23X2-4f	520.3	4.8104	2.40E-04	16.0386	0.001508	321.405	0.030	2.556	0.138	0.009	0.197	0.005	0.167	0.007
	JTM-23X2-8a	531.4	4.8033	4.43E-04	16.0409	0.002528	320.501	0.050	2.554	0.009	0.014	0.117	0.009	0.063	0.012
	JTM-23X2-8e	531.4	4.8035	2.17E-03	16.1053	0.010841	321.815	0.205	5.120	0.196	0.058	0.233	0.036	0.215	0.047
	JTM-23X2-10a	568.9	4.7962	2.05E-03	16.0986	0.010141	320.708	0.193	2.565	0.038	0.055	0.135	0.034	0.087	0.045
	JTM-23X2-10b	568.9	4.7970	5.80E-04	16.0790	0.002961	320.433	0.065	3.080	-0.001	0.019	0.111	0.012	0.055	0.015
	JTM-23X2-10c	568.9	4.8070	4.07E-04	16.0446	0.002350	321.076	0.048	2.581	0.091	0.014	0.168	0.009	0.129	0.011
	JTM-23X2-10d	568.9	4.8017	6.23E-04	16.0799	0.003506	321.079	0.069	3.592	0.091	0.020	0.168	0.012	0.130	0.016
	JTM-23X2-10e	568.9	4.7932	1.17E-03	16.1094	0.000622	320.523	0.124	2.665	0.012	0.035	0.119	0.022	0.065	0.029

D31	JTM-23X2-10f	568.9	4.8050	4.92E-04	16.0315	0.004652	320.539	0.084	2.660	0.014	0.024	0.120	0.015	0.067	0.019
	JTM-23X2-12a	579.9	4.8047	1.62E-03	16.0905	0.008513	321.687	0.160	3.782	0.178	0.046	0.222	0.028	0.200	0.037
	JTM-23X2-12b	579.9	4.8059	5.87E-04	16.0641	0.000324	321.315	0.064	3.673	0.125	0.018	0.189	0.011	0.157	0.015
	JTM-23X2-12c	579.9	4.8032	3.95E-04	16.0682	0.002385	321.036	0.047	2.525	0.085	0.013	0.164	0.008	0.125	0.011
	JTM-23X2-12d	579.9	4.8061	1.04E-03	16.0647	0.005496	321.352	0.103	3.921	0.130	0.029	0.192	0.018	0.161	0.024
	JTM-23X2-16a	612.6	4.8069	6.65E-04	16.0448	0.003741	321.069	0.071	3.536	0.090	0.020	0.167	0.013	0.129	0.016
	JTM-23X2-16b	612.6	4.8039	2.23E-03	16.0437	0.010877	320.645	0.205	4.877	0.029	0.058	0.130	0.036	0.080	0.047
	JTM-23X2-16c	612.6	4.8078	5.70E-04	16.0292	0.003204	320.878	0.063	4.242	0.062	0.018	0.150	0.011	0.106	0.015
	JTM-23X2-16d	612.6	4.8060	1.01E-03	16.0355	0.005466	320.766	0.110	6.102	0.047	0.031	0.141	0.019	0.094	0.025
	JTM-23X2-16e	612.6	4.8074	8.26E-04	16.0368	0.004420	320.978	0.085	4.439	0.077	0.024	0.159	0.015	0.118	0.020
	JTM-23X2-16f	612.6	4.8073	1.11E-03	16.0312	0.005758	320.849	0.111	5.085	0.058	0.032	0.148	0.020	0.103	0.026
	JTM-23X2-23b	631.2	4.8063	2.09E-03	16.1326	0.010015	322.738	0.186	3.262	0.328	0.053	0.315	0.033	0.322	0.043

D32	JTM-23X2-23c	631.2	4.8096	6.42E-04	16.0938	0.003514	322.415	0.069	3.922	0.282	0.020	0.287	0.012	0.284	0.016
	JTM-23X2-23d	631.2	4.8097	2.88E-04	16.0467	0.001322	321.475	0.030	1.917	0.148	0.009	0.203	0.005	0.176	0.007
	JTM-23X2-25a	632.2	4.8114	9.09E-04	16.0712	0.005099	322.193	0.100	2.339	0.250	0.029	0.267	0.018	0.259	0.023
	JTM-23X2-25b	632.2	4.8121	1.26E-03	16.0646	0.006414	322.164	0.131	2.142	0.246	0.037	0.264	0.023	0.255	0.030
	JTM-23X2-25c	632.2	4.8105	7.11E-04	16.0755	0.003983	322.160	0.079	1.640	0.245	0.023	0.264	0.014	0.255	0.018
	JTM-23X2-25d	632.2	4.8082	1.03E-03	16.1047	0.005672	322.439	0.112	2.245	0.285	0.032	0.289	0.020	0.287	0.026
	JTM-23X2-25e	632.2	4.8068	1.67E-03	16.0796	0.008209	321.755	0.152	2.534	0.188	0.043	0.228	0.027	0.208	0.035
	JTM-23X2-32a	665.0	4.8071	4.29E-03	16.1036	0.020607	322.277	0.362	4.659	0.262	0.103	0.274	0.064	0.268	0.084
	JTM-23X2-32b	665.0	4.8056	4.81E-04	16.0802	0.002744	321.601	0.053	4.164	0.166	0.015	0.215	0.009	0.190	0.012
	JTM-23X2-36b	669.4	4.8051	8.45E-04	16.0561	0.004667	321.050	0.091	NA	0.087	0.026	0.166	0.016	0.126	0.021
	JTM-23X2-36e	669.4	4.8083	7.12E-04	16.0417	0.004050	321.188	0.080	2.567	0.107	0.023	0.178	0.014	0.142	0.019
	JTM-23X2-37a	672.1	4.8063	2.56E-04	16.0265	0.001613	320.627	0.032	4.555	0.027	0.009	0.128	0.006	0.077	0.007

D33

JTM-23X2-37b	672.1	4.8053	9.83E-04	16.0426	0.005046	320.807	0.099	3.555	0.052	0.028	0.144	0.018	0.098	0.023
JTM-23X2-37c	672.1	4.8071	2.23E-04	16.0324	0.001402	320.847	0.028	4.100	0.058	0.008	0.148	0.005	0.103	0.006
JTM-23X2-37d	672.1	4.8065	2.79E-04	16.0399	0.001671	320.919	0.034	4.040	0.068	0.010	0.154	0.006	0.111	0.008
JTM-23X2-37e	672.1	4.8057	3.80E-04	16.0323	0.002186	320.661	0.044	2.943	0.032	0.013	0.131	0.008	0.081	0.010
JTM-23X2-37f	672.1	4.8026	8.56E-04	16.0555	0.004435	320.701	0.085	3.917	0.037	0.024	-28.274	0.015	0.000	0.020
JTM-23X2-37g	672.1	4.7932	3.11E-03	16.1400	0.015140	321.132	0.284	3.449	0.099	0.081	0.173	0.050	0.136	0.066
JTM-23X2-41a	676.9	4.8080	9.67E-04	16.0800	0.005187	321.914	0.098	4.330	0.210	0.028	0.242	0.017	0.226	0.023
JTM-23X2-41b	676.9	4.8041	1.19E-03	16.1047	0.006363	321.884	0.121	4.972	0.206	0.035	0.240	0.021	0.223	0.028
JTM-23X2-41c	676.9	4.8104	2.45E-04	16.0457	0.001481	321.552	0.029	2.418	0.159	0.008	0.210	0.005	0.184	0.007
JTM-23X2-41d	676.9	4.8104	2.00E-04	16.0529	0.001216	321.697	0.025	2.375	0.179	0.007	0.223	0.004	0.201	0.006
JTM-23X2-41e	676.9	4.8066	8.24E-04	16.0812	0.004622	321.759	0.088	3.636	0.188	0.025	0.229	0.016	0.208	0.020

Note: All mole fraction values are reported relative to x, (Fe/Ca(Fe<sub>x</sub>Mg<sub>1-x</sub>)(CO<sub>3</sub>)<sub>2</sub>)

\*Calculation based on Chai and Navrotsky (1996), volume equation

\*\*Calculation based on Reeder and Dollase (1989), volume equation

\*\*\*Calculation is the average of Chai and Navrotsky (1996) and Reeder and Dollase (1989)

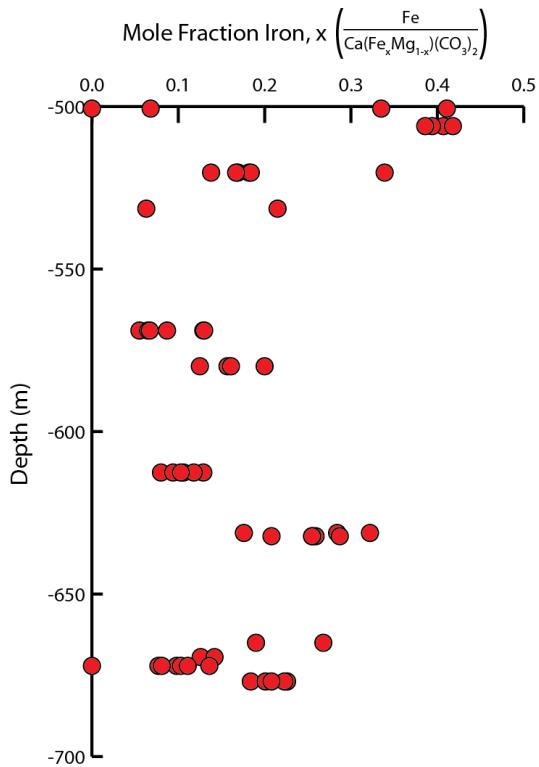


Figure 9. Calculated mole fraction of iron in dolomite samples of the Shell 23X-2 Core. Lattice parameters were derived from the program GSAS (Larson and Von Dreele, 2000) and values result from averaging the answers from equations by Reeder and Dollase (1989) and Chai and Navrotsky (1996).

## **Appendix E: Stable Isotope Results**

Part 1: ERDA 1 Blacks Fork Core

Table 9. Sample number, depth, and stable isotope results of select laminae from the Shell 23X-2 Core, Piceance Creek Basin, Colorado.

Sample #	Depth (m)	$\delta^{13}\text{C}_{\text{CARB}}$ (vpdb) ‰	$\delta^{18}\text{O}_{\text{CARB}}$ (vpdb) ‰	$\delta^{18}\text{O}_{\text{H}_2\text{O}}$ (vsmow) ‰
BF-39b	295.6	1.03	-3.71	-
BF-39c	295.6	1.30	-3.52	-
BF-39d	295.6	2.28	-1.69	-32.13
BF-44a	306.9	0.79	-4.22	-
BF-44b	306.9	1.23	-2.13	-32.56
BF-44c	306.9	0.93	-4.36	-
BF-50a	329.5	3.07	-4.18	-
BF-55a light	347.9	3.40	-2.87	-33.27
BF-55a dark	347.9	3.62	-0.90	-31.-37
BF-55d	347.9	3.49	-2.78	-33.19
BF-64a	367.0	1.53	-1.39	-31.85

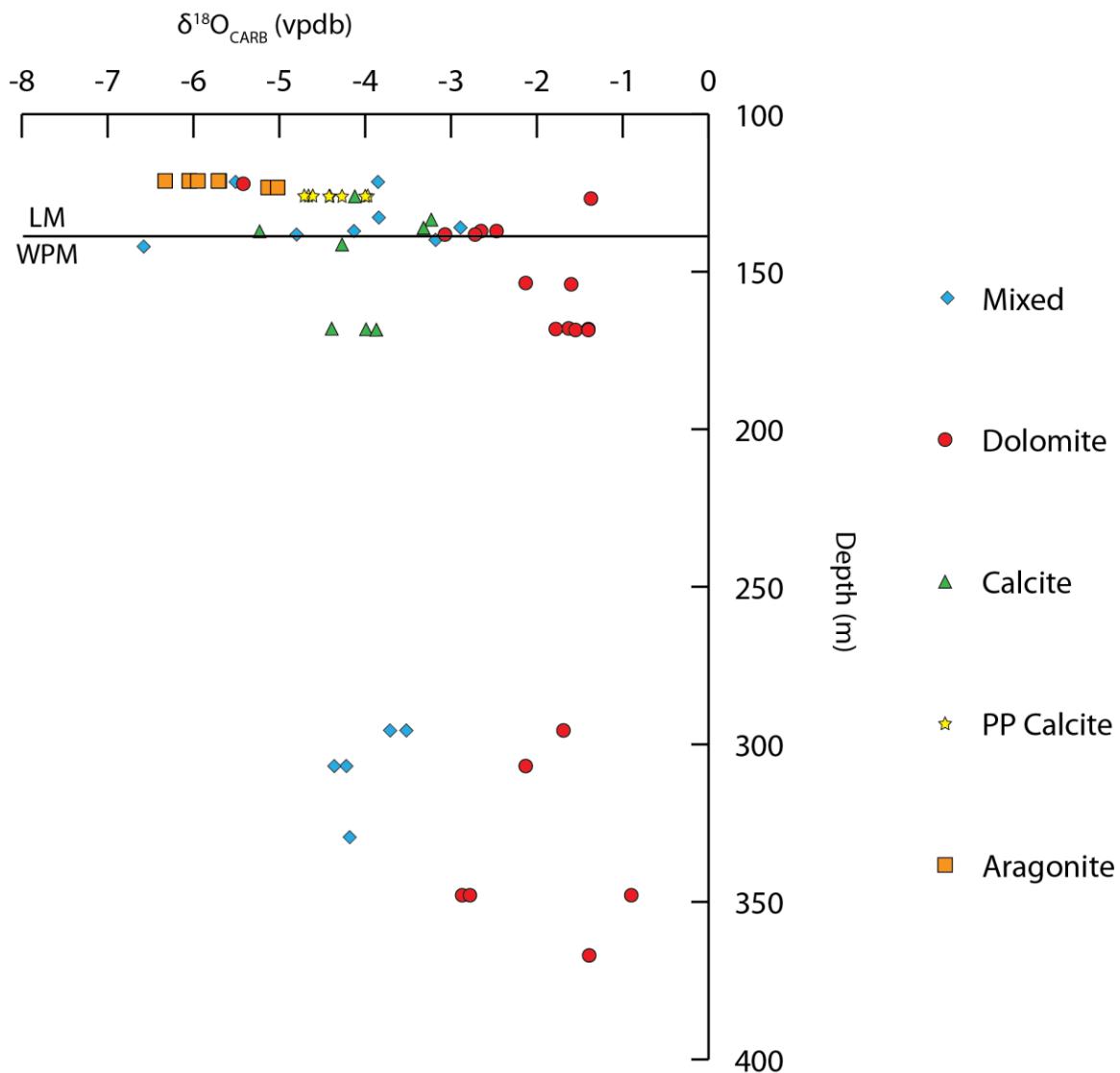


Figure 10.  $\delta^{18}\text{O}$  stable isotope data for carbonate laminae sampled from the ERDA 1 Blacks Fork Core. “PP Calcite” indicates primary precipitated calcite.

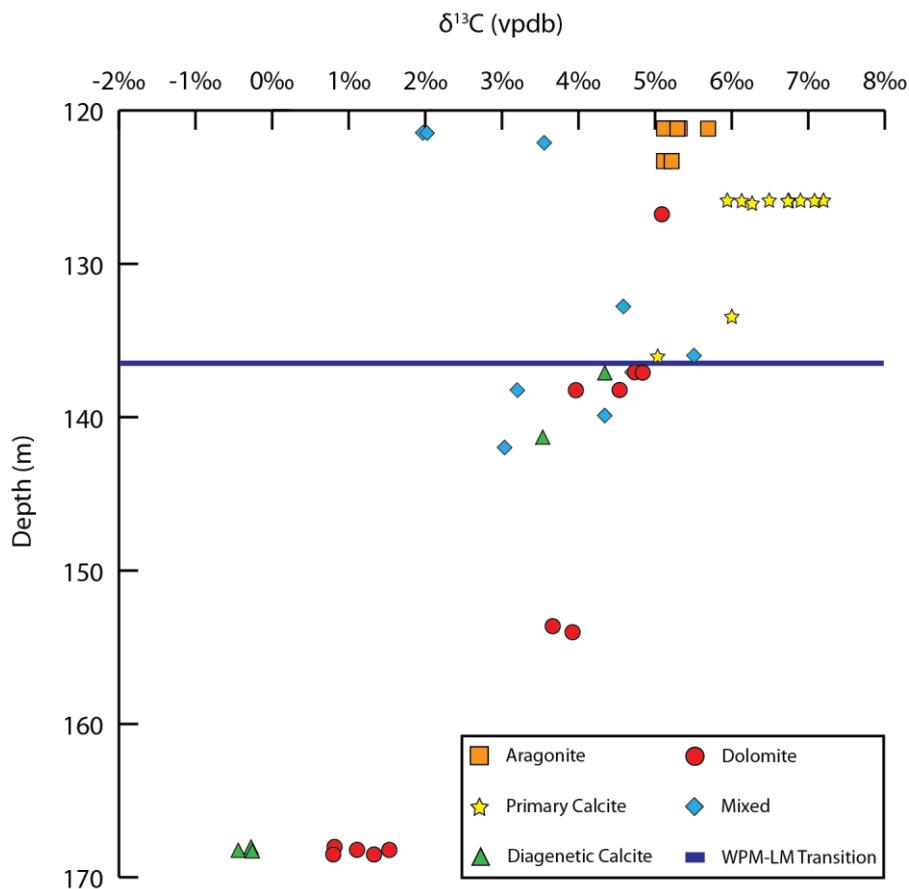


Figure 11. Measured  $\delta^{13}\text{C}$  values from carbonate laminae of the ERDA 1 Blacks Fork Core at the WPM-LM transitional zone.

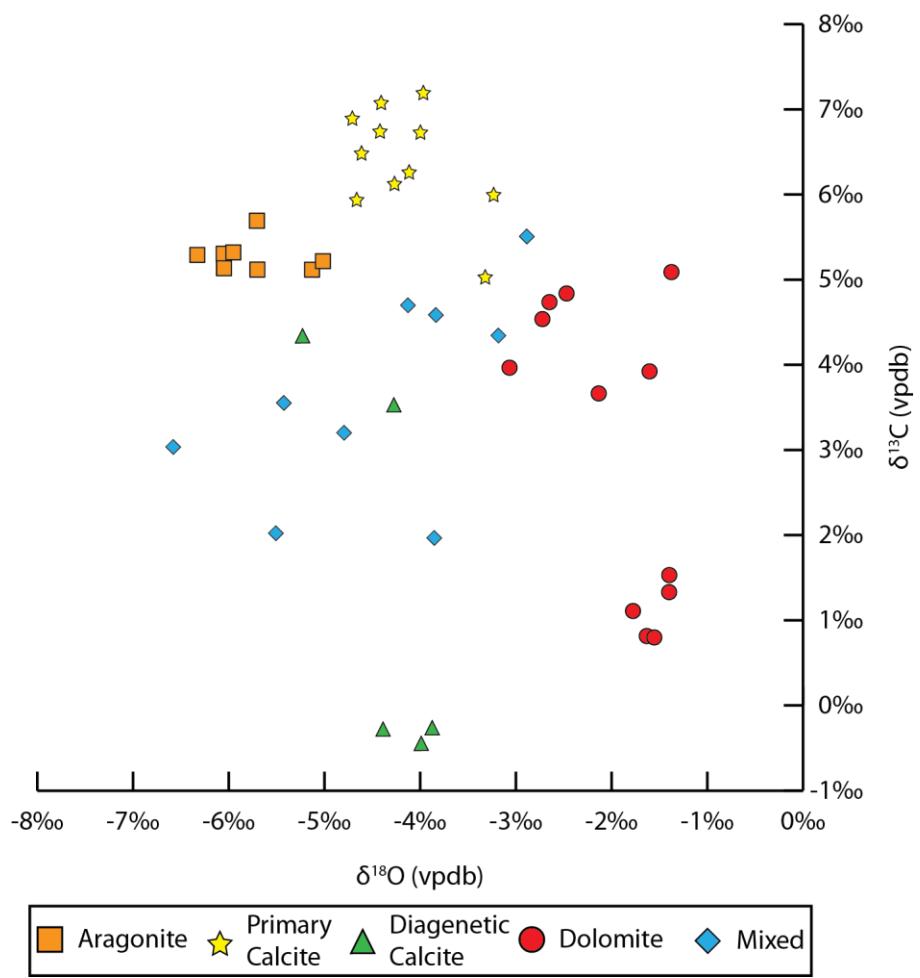


Figure 12. Relationship of  $\delta^{18}\text{O}$  versus  $\delta^{13}\text{C}$  in alkaline earth carbonate laminae from the WPM-LM transition zone of the ERDA 1 Blacks Fork Core.

## Part 2: Shell 23X-2 Core

Table 10. Sample number, depth, and stable isotope results of select laminae from the Shell 23X-2 Core, Piceance Creek Basin, Colorado.

Sample #	Depth (m)	$\delta^{13}\text{C}_{\text{CARB}}(\text{vpdb})$ ‰	$\delta^{18}\text{O}_{\text{CARB}}(\text{vpdb})$ ‰	$\delta^{18}\text{O}_{\text{H}_2\text{O}}$ (vsmow) ‰
23x2-1d	500.67	5.00	-1.92	-2.50
23x2-2a	505.97	5.01	-2.68	-3.25
23x2-2b	505.99	5.38	-2.58	-3.16
23x2-4b	520.31	5.31	-3.55	-4.13
23x2-16e	612.60	4.72	-4.30	-4.87
23x2-23c	631.19	1.70	-4.89	-5.46
23x2-41c	676.89	5.89	-3.21	-3.78
23x2-41d	676.90	5.94	-3.48	-4.05

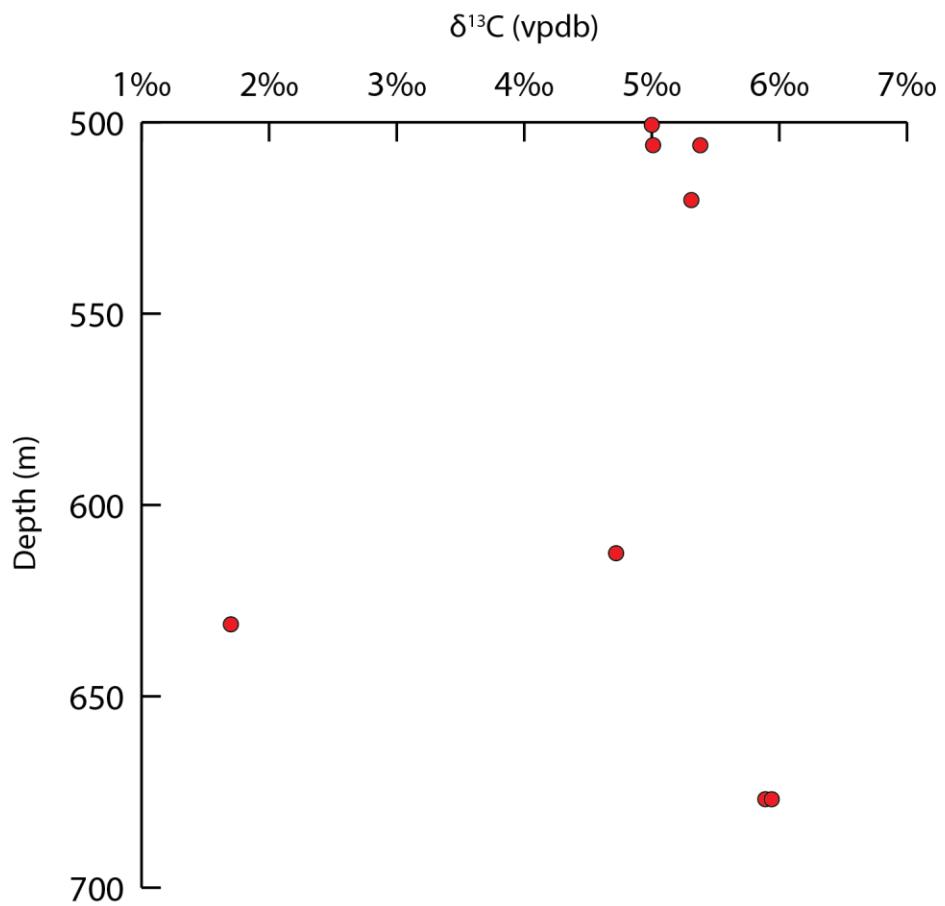


Figure 13. Measured  $\delta^{13}\text{C}$  values from carbonate samples of the Shell 23X-2 Core.

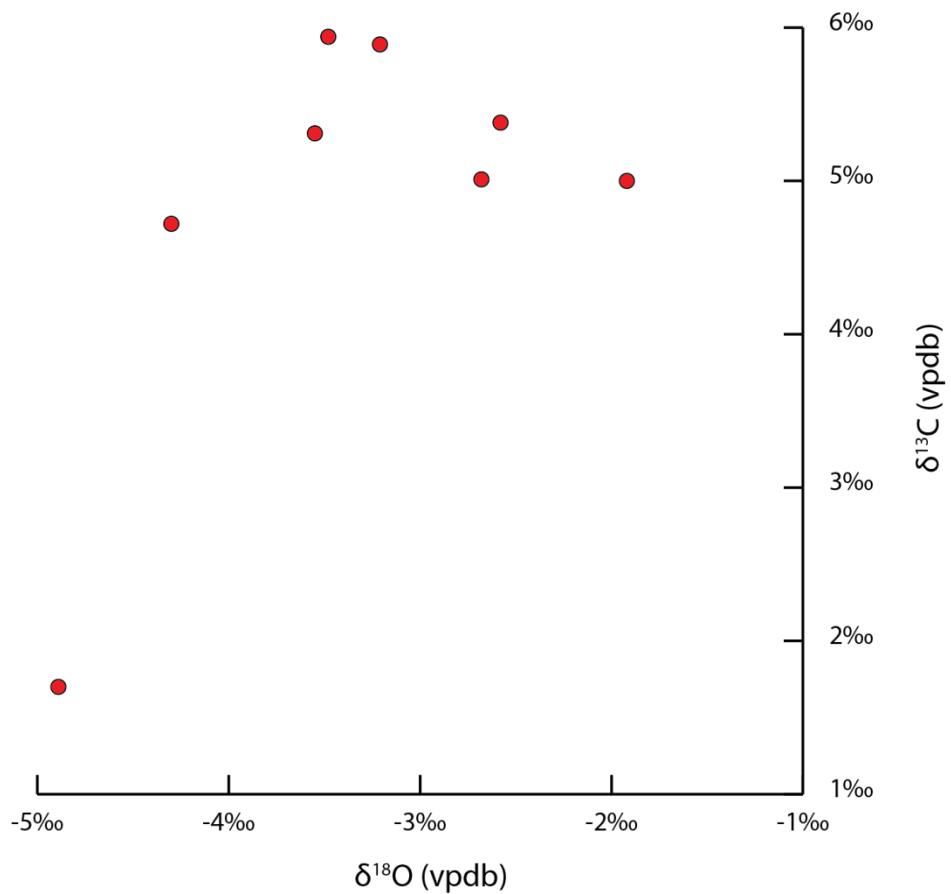


Figure 14. Relationship of  $\delta^{18}\text{O}$  versus  $\delta^{13}\text{C}$  in alkaline earth carboantes from the Shell 23X-2 Core, CO.

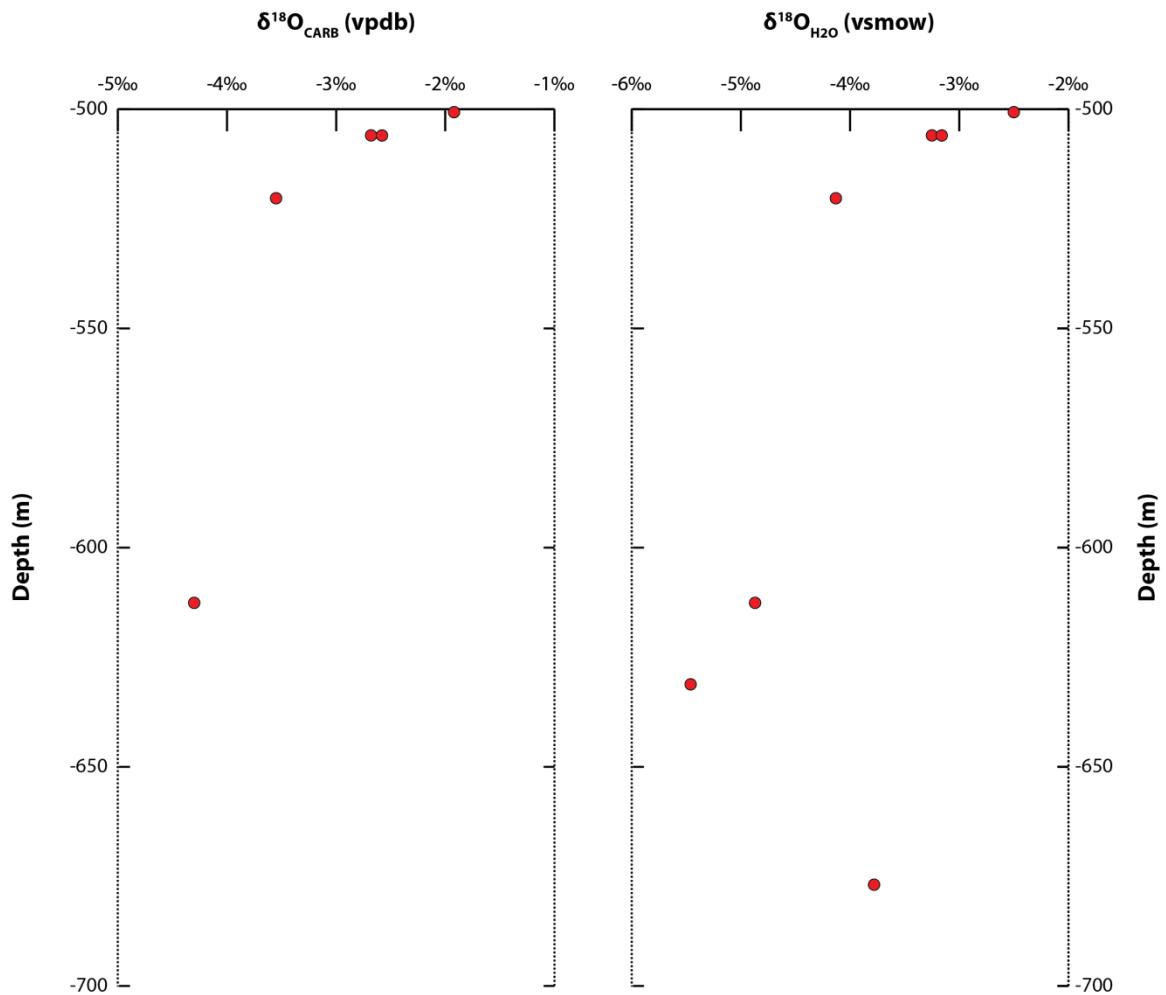


Figure 15.  $\delta^{18}\text{O}$  stable isotope data for carbonate and estimated lake water for samples from the Shell 23X-2 Core, Piceance Creek Basin, Colorado.

**Appendix F: Additional Images From the ERDA 1 Blacks Fork Core**

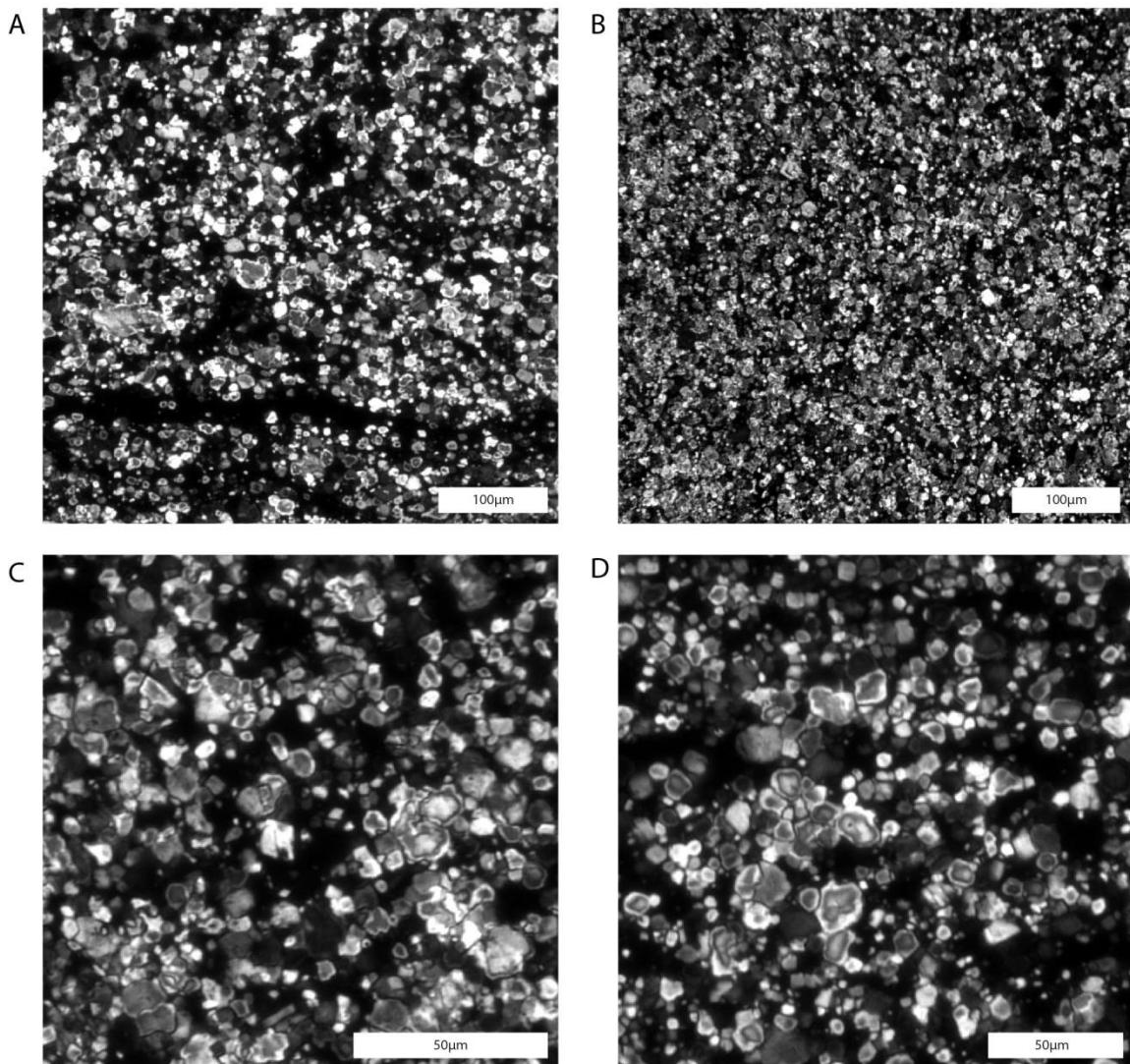


Figure 16. Thin section images of primary precipitated alkaline earth carbonates from the ERDA 1 Blacks Fork Core. Sample A is from JTM-BF-8 at 125.8m in the LM, Sample B from JTM-BF-17 at 136.0m in the LM, Sample C from BF-57 at 351.7m in the WPM, and Sample D from JTM-BF-64 at 367.0m in the WPM. A and B) Primary precipitated calcite laminae from the LM make up ~10 $\mu$ m crystals and are pure. Amorphous dark areas are organic matter. C and D) The textures observed from primary precipitated calcite in the LM are identical to textures observed from primary precipitated dolomite in the WPM. Samples C and D derive from pure dolomite laminae and are composed of

<15 $\mu\text{m}$  crystals. Primary pore space is preserved and the crystals are very well sorted and homogeneous.

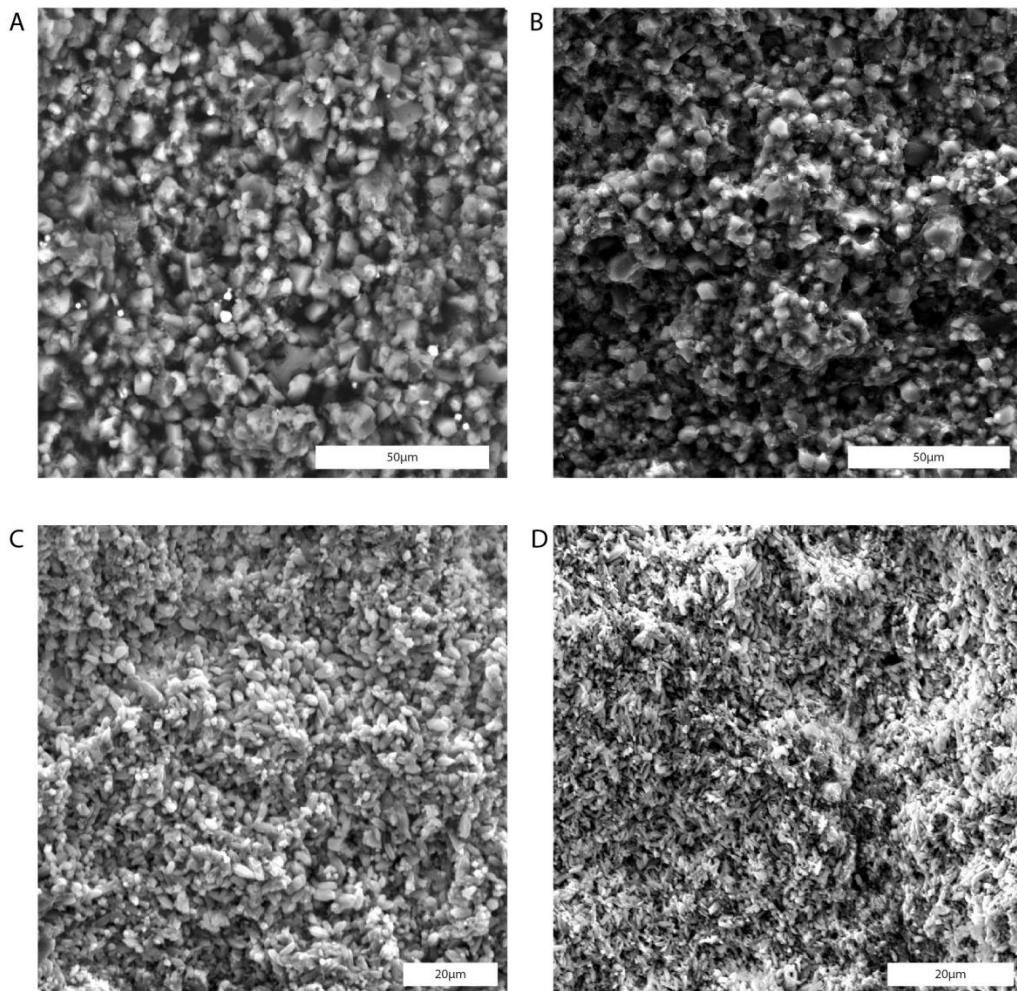


Figure 17. SEM images of primary precipitated carbonate laminae from the ERDA 1 Blacks Fork Core. Sample A is from JTM-BF-8 at 125.8m in the LM, Sample B from JTM-BF-17 at 136.0m in the LM, Sample C from JTM-BF-2 at 121.5m, and Sample D from JTM-BF-5 at 123.3m in the LM. A and B) Backscatter SEM image (A) and SEM image (B) of primary precipitated calcite crystals. The crystals form homogeneous laminae that are well sorted, monomineralllic, and composed of ~10 $\mu$ m equant crystals. Primary pore space is also preserved. C and D) Primary aragonite laminae also make up monomineralllic, homogeneous laminae. However, the crystals are instead prismatic needles, about 10 $\mu$ m in length.

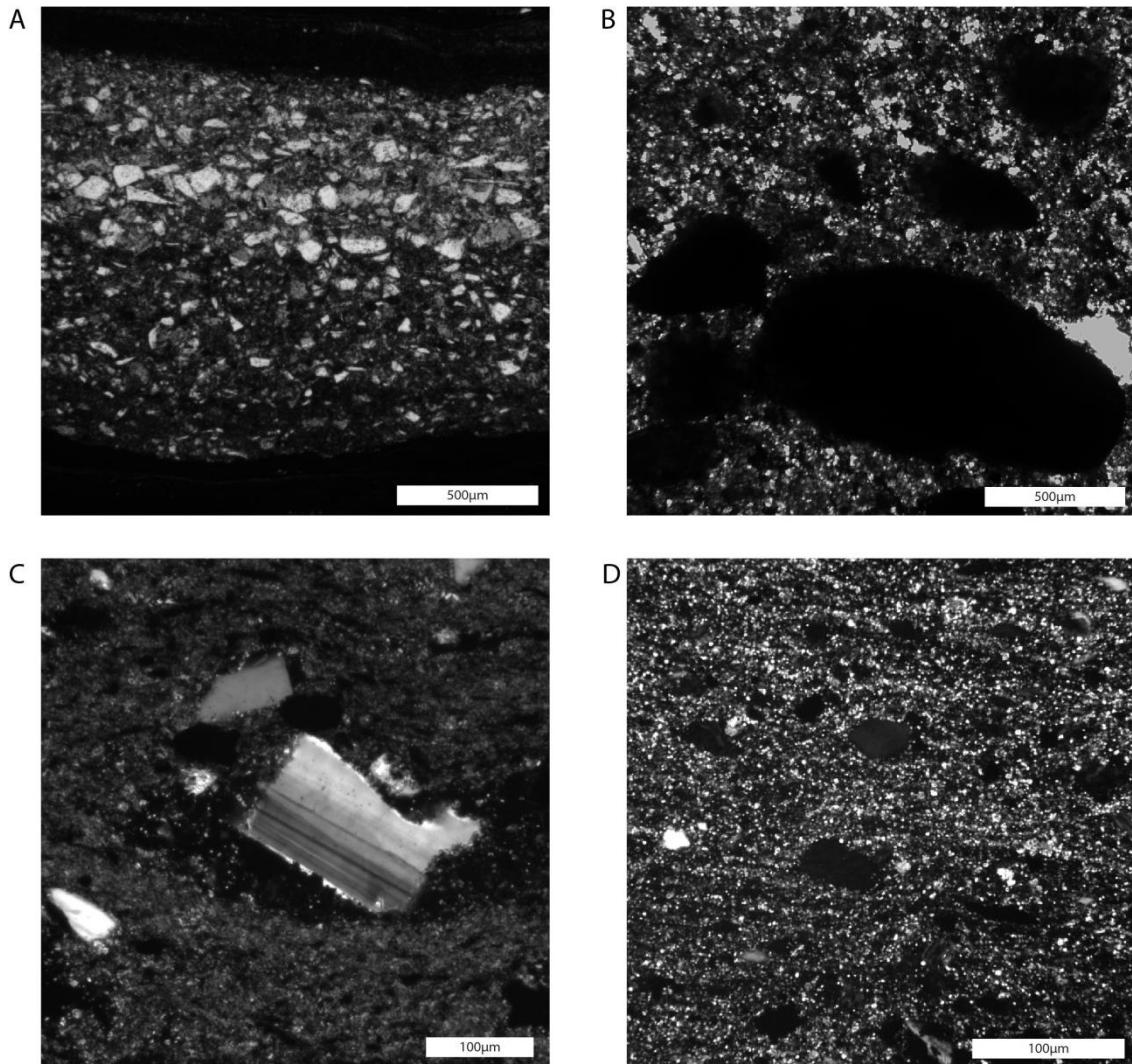


Figure 18. Thin section images of detrital laminae from the ERDA 1 Blacks Fork Core. Images A, C, and D derive from the Laney Member whereas B is from the WPM. Sample A is from JTM-BF-4 at 122.1m, Sample B from JTM-BF-44 at 306.9m, Sample C from JTM-BF-3 at 121.5m, and Sample D from BF-10 at 126.8m. A) Two detrital laminae are shown in this image with a thin organic film marking the boundary. In the lower lamina, peloidal fabrics are recognized and grains are well sorted. In the upper lamina grains are more poorly sorted and display normal gradation. Mineralogy from these laminae is composed of dolomite, feldspar, buddingtonite, and quartz. B) Large clasts mixed in with

finer material are intermixed in this conglomerate lamina. The clasts can reach upwards of several cm in diameter. The clasts are also well rounded and flattened. C) Associated feldspar grains were very common in carbonate laminae with a detrital origin. D) Many of the detrital laminae were grain rich with heterogeneous grain sizes and abundant feldspar and quartz.

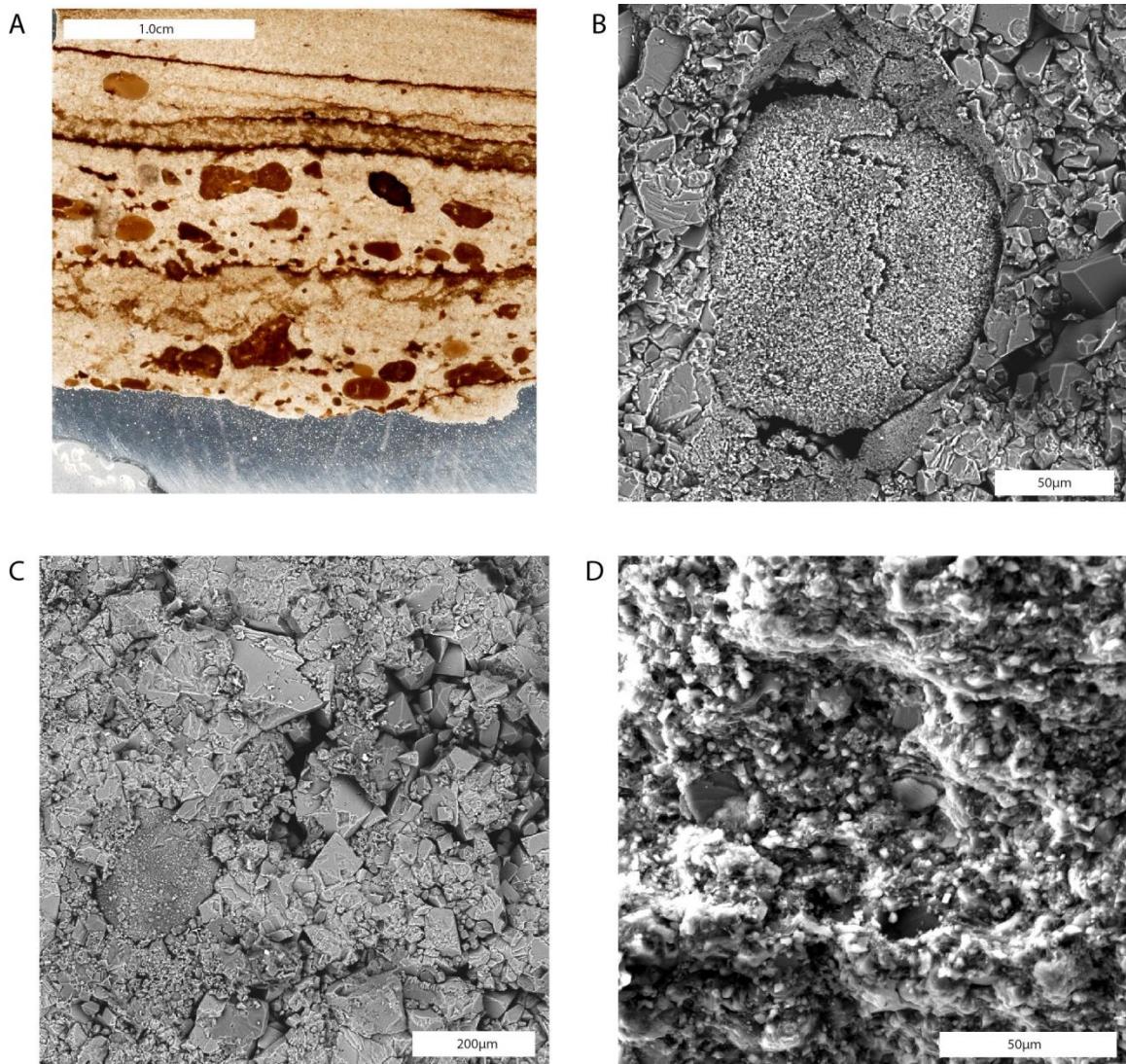


Figure 19. Hand sample (A) and SEM images (B, C, D) of detrital laminae from the ERDA 1 Blacks Fork Core. Samples A, B, and C derive from JTM-BF-44 at 306.69m in the WPM, and Sample B from JTM-BF-3 at 121.5m in the LM. A) Hand sample image showing conglomerate laminae from the WPM. The clasts and matrix are predominantly dolomite. B) SEM image of a clast from the conglomerate laminae shows a very well rounded grain within a diagenetically altered heterogeneous matrix. C) The conglomerate laminae from JTM-BF-44 are heterogeneous in grain sizes with the rounded clasts deriving from a detrital origin and matrix material resulting from diagenetic overgrowths

of well-developed dolomite rhombohedra. D) Detrital laminae in the LM are either calcite or dolomite rich or both. In this image, heterogeneous grains are made up of aragonite, calcite, feldspar, and quartz. Grain sizes are varied and sorting is poor.

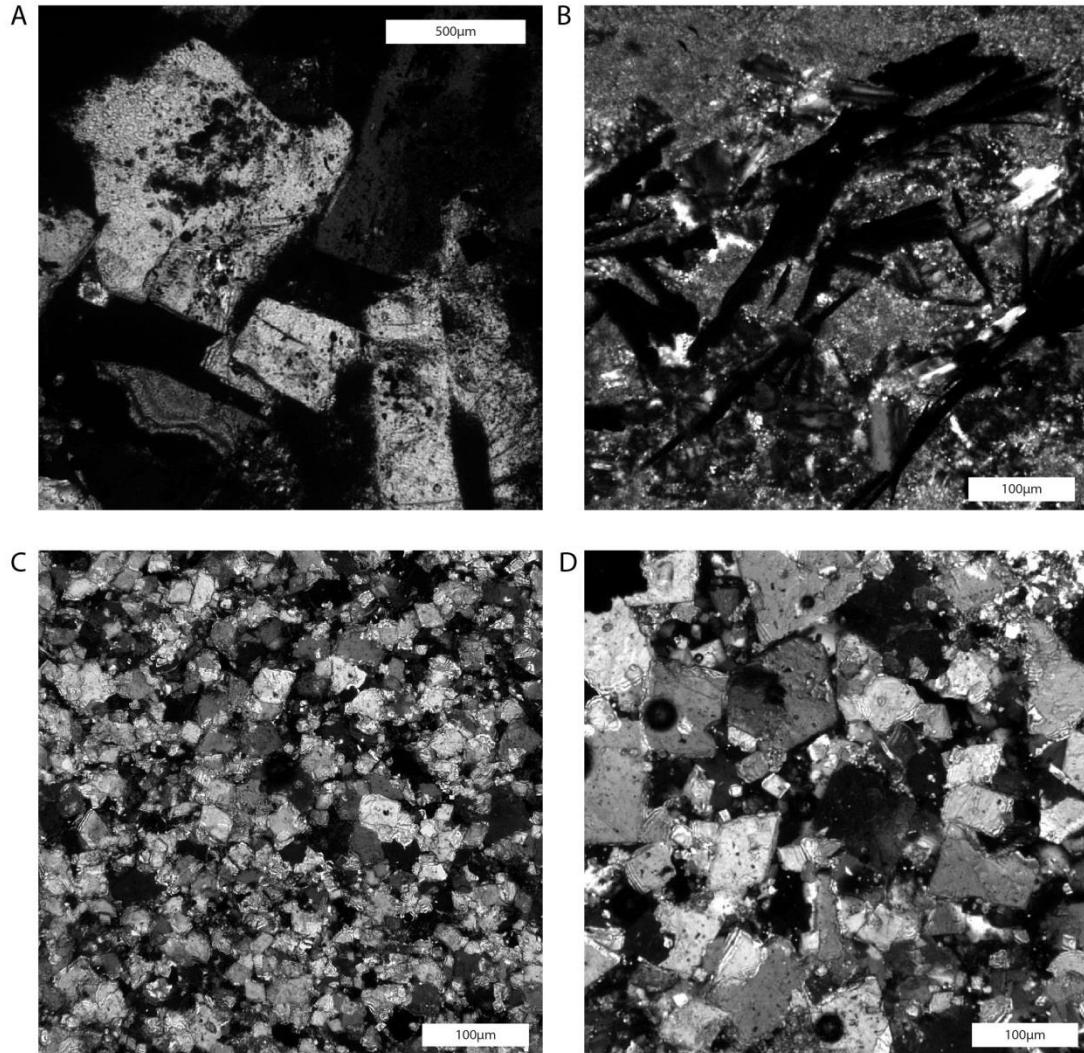


Figure 20. Thin section images of diagenetic carbonate laminae from the WPM in the ERDA 1 Blacks Fork Core. Sample A is from JTM-BF-23 at 144.1m, Sample B from JTM-BF-24 at 146.6m, Sample C from JTM-BF-18 at 137.1m, and Sample D from JTM-BF-44 at 306.69m. A) Shortite crystals occur in dolomite-rich laminae and disrupt all primary structures and cross cut laminae boundaries. The crystal scan also exceed >200µm lengths. B) Pyrrhotite also disrupts lamination in carbonate laminae from the WPM and is composed of needle-shape textures that can be several 100µm. These are most often found in dolomite-rich lamina. C and D) Mixed calcite dolomite laminae from

the WPM commonly make up interlocking crystalline mosaics as seen in these thin section images. Cement is abundant and pore space is absent.

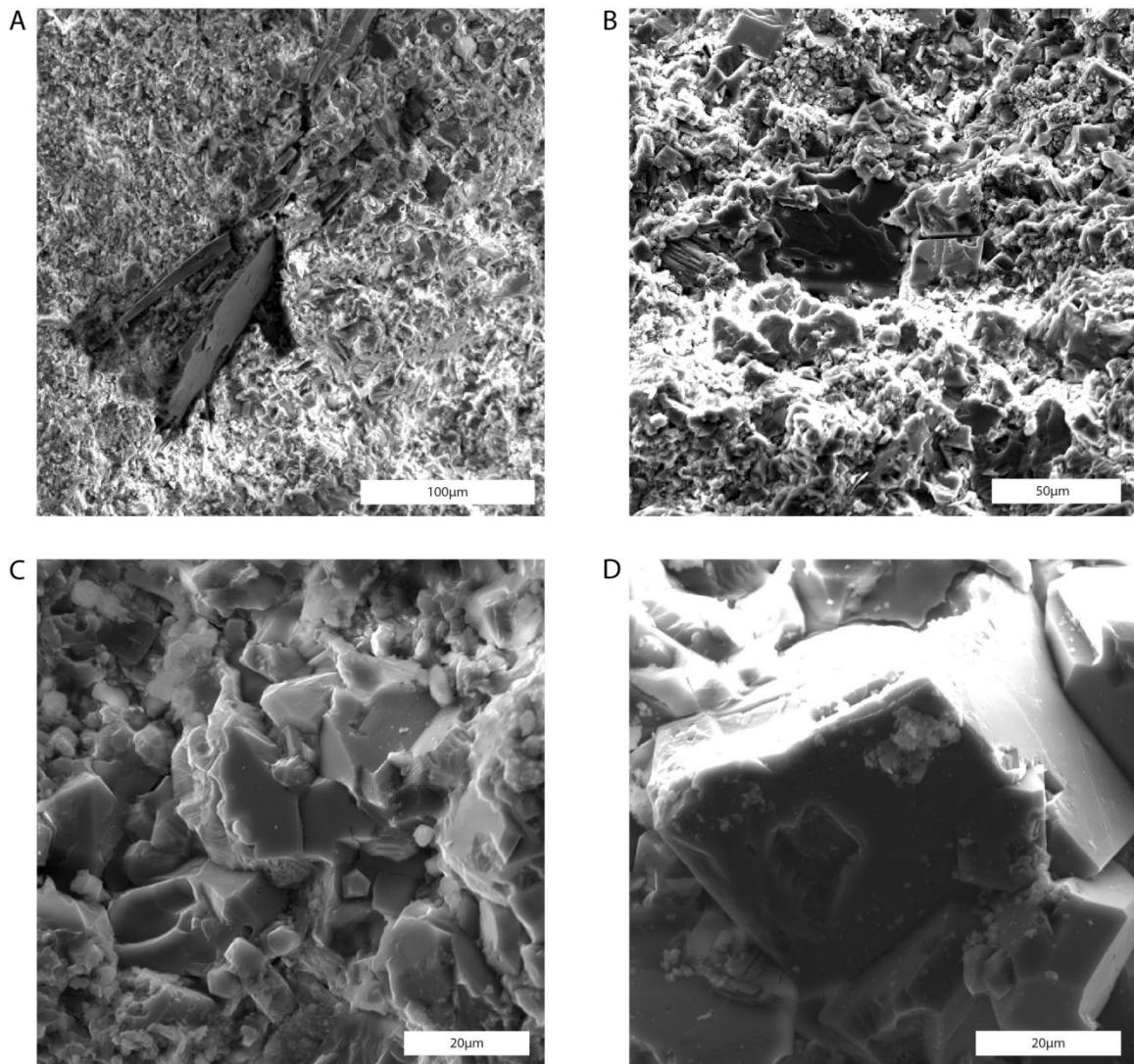


Figure 21. SEM images of diagenetic carbonate laminae from the WPM in the ERDA 1 Blacks Fork Core. Sample A is from JTM-BF-21 at 141.3m, Sample B from JTM-BF-34 at 168.2m, Sample C from JTM-BF-19 at 138.2m, and Sample D from JTM-BF-44 at 306.9m. A) SEM image of disruptive pyrrhotite growth in a dolomite-rich matrix. Pyrrhotite appears to form thin blades within the carbonate lamina. B and C) Diagenetic laminae from the WPM have heterogeneous textures with high variations in crystals sizes and shapes. In these images, crystals range from  $<5\mu\text{m}$  to  $>50\mu\text{m}$ . Dolomite rhombs form well-developed crystal faces and boundaries from post depositional overgrowth whereas

calcite makes up the majority of the finer <10 $\mu\text{m}$  crystals. D) Diagenetic dolomite from the WPM forms well-developed crystal faces and boundaries. These rhombahedra are euhedral and can grow much larger than surrounding crystalline silt and clay.